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Staff Studies

Nuclear Accident and Recovery at Three Mile Island

A Special Investigation

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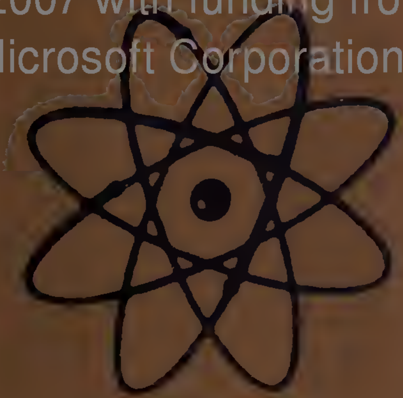

Subcommittee on Nuclear Regulation
for the
Senate Committee on Environment & Public Works

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COMMITTEE PRINT

STAFF STUDIES

NUCLEAR ACCIDENT AND RECOVERY AT THREE MILE ISLAND

SUBCOMMITTEE ON NUCLEAR REGULATION

FOR THE

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

U.S. SENATE

JULY 1980

SERIAL NO. 96–14 A

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LETTER OF SUBMITTAL

United States Senate,
Committee on Environment and Public Works,
Washington, D.C., June 30, 1980.

The Honorable Jennings Randolph,
Chairman,
The Honorable Robert T. Stafford,
Ranking Minority Member,
Senate Committee on Environment and Public Works,
Washington, D.C.

Dear Jennings and Bob: We are pleased to submit to the Committee a series of studies on major issues arising out of the Three Mile Island accident. These studies were conducted primarily by the Special Investigation staff, with substantial contributions by the General Accounting Office and by the Congressional Research Service.

The Subcommittee's report, *Nuclear Accident and Recovery at Three Mile Island*, identified a number of serious deficiencies in the civilian nuclear power program. These studies assess the adequacy of several of the post-accident programs developed by the Nuclear Regulatory Commission and by the nuclear industry to correct these shortcomings, recognizing that their success bears directly on this Nation's ability to operate nuclear plants safely. We trust that these studies will prove useful to the Committee in exercising its jurisdiction over the non-military environmental control and regulation of nuclear energy.

These studies complete the Committee's one-year task of investigating the accident at Three Mile Island and the major issues arising out of the accident. We again extend our appreciation for your fine support and assistance throughout the term of this project.

Sincerely,

Gary Hart, *Chairman,*
Subcommittee on Nuclear Regulation.
Alan K. Simpson,
Ranking Minority Member,
Subcommittee on Nuclear Regulation.

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INTRODUCTION

On June 29, 1979, the Senate approved Senate Resolution 171, which provided funds for the Committee on Environment and Public Works to conduct a Special Investigation of the nuclear accident at Three Mile Island and a series of related studies on civilian use of nuclear power. These tasks were carried out for the Committee by its Subcommittee on Nuclear Regulation.

The Committee already has transmitted to the Senate the Subcommittee's investigation report on the accident at Three Mile Island. This second volume contains the separate studies and fulfills the remainder of the assignment.

The Senate investigation, as did other analyses of the accident, revealed major deficiencies in the civilian nuclear power program. The studies in this volume focus principally on the steps thus far taken by the Nuclear Regulatory Commission (NRC) and the nuclear industry to correct these deficiencies. Since many of the activities initiated after the accident are still relatively new, it is too early to make a definitive assessment of their adequacy. The studies do identify, however, emerging or potential difficulties in the new programs as well as issues still unresolved. Where appropriate, the studies also make recommendations for change.

Of the 13 studies, seven were conducted by the Special Investigation staff, whose names appear with the chapter for which they were responsible; the others were prepared at the request of the Subcommittee by the General Accounting Office and the Congressional Research Service.

Part I of this volume addresses actions by the Nuclear Regulatory Commission. The TMI accident disclosed a number of serious deficiencies in the agency's ability to respond effectively to an emergency. Since then, the agency has given much attention to its emergency response capability, the subject of Chapter 1. The Special Investigation studied the NRC's emergency response efforts and found that while much had been improved, much remained to be done. It is still unclear how much more effectively the NRC would be able to respond to another serious nuclear accident were one to occur today.

Chapter 2 contains the Special Investigation's review of the Nuclear Regulatory Commission's safety goals and its "backfit" process—the means by which the agency determines what modifications should be made to an already licensed reactor to satisfy a safety need identified subsequent to issuance of the license. An effective backfitting process is needed to resolve the safety deficiencies uncovered by the investigation of the accident as well as future safety problems. In addition, a set of basic safety goals, capable of implementation, would be useful in assuring the consistent application of necessary safety requirements.

Another significant problem exposed by the accident was the inadequate attention given to human factors in the design and operation of nuclear plants, the focus of Chapter 3. The Special Investigation, with the aid of the Congressional Research Service, studied the NRC's post-accident efforts in three areas critical to safe operations in which human factors are of particular importance: control room design, operator training and licensing, and procedures governing plant operations.

At the request of the Subcommittee, the General Accounting Office analyzed the NRC's Three Mile Island Lessons Learned Action Plan, which lists and prioritizes specific actions requiring implementation by the agency in the wake of the accident. The purpose of the agency's review was to insure that the NRC had developed an effective system for assimilating the many TMI-related recommendations and for taking appropriate corrective action. The GAO study appears as Chapter 4.

The investigation of the accident revealed that despite the existence of some operating commercial reactors, the Nuclear Regulatory Commission did not have an effective, systematic program for evaluating potentially valuable operating information, pinpointing potential problems and taking appropriate preventive action. Chapter 5 assesses the steps taken by the agency since Three Mile Island to rectify this prominent deficiency. Although progress has been made, there are troubling indications that the new NRC office established to provide agency-wide oversight may not have the necessary authority to do the job effectively.

Although the NRC is responsible for regulating the commercial use of nuclear power, utility operators actually run the plants. Thus the licensed operators specifically and the commercial nuclear industry in general bear a heavy responsibility for the safety of commercial nuclear reactors. Part II contains studies on some of the programs initiated by industry.

The Special Investigation staff conducted a review of some of the principal elements of the industry's response to the Three Mile Island accident, particularly the development of the Institute for Nuclear Power Operations (INPO) and the Nuclear Safety Analysis Center (NSAC)—two organizations established since TMI to improve the safe operation of reactors. This study, the subject of Chapter 1, focuses on these elements of the industry's efforts in the same critical areas of concern covered by the studies on the NRC's response—the industry's need to develop an effective system for evaluation of operating information, to pay far closer attention to the human element of reactor safety in operator training, control room design and operating procedures and to establish a reliable emergency response capability.

The Special Investigation examined the cleanup and recovery operations at TMI, including the financial aspects of recovery. It found that the General Public Utilities (GPU) system, of which the Three Mile Island plant is a part, has been under severe financial stress, largely because of the enormous expense of the replacement electric power it has purchased to replace the lost output of TMI Units 1 and 2. Chapter 2 contains an examination of the Nuclear Energy Insurance, Ltd. (NEIL), a mutual insurance program developed by the nuclear industry in response to this lesson of TMI. The study indicates that the industry has not yet firmly linked participation in NEIL to the safety standards being developed by the Institute for Nuclear Power Operations, a potentially important tie that could further motivate a utility to meet the Institute of Nuclear Power Operation's standards for safety.

In light of the apparent post-accident financial difficulties suffered by the GPU companies, the Committee asked GAO to provide a detailed analysis of the companies' present condition and forecast for the future, recognizing that financial considerations potentially affect the critical task of cleanup. Chapter 3 contains GAO's analysis, which was also published separately by that organization.

As noted in the report of the Senate Special Investigation, prior to Three Mile Island the utilities were largely responsible for operator training. The accident revealed serious weaknesses in the preparation of plant operators at Three Mile Island. The Subcommittee requested that the Congressional Research Service look into activities to upgrade training and licensing of operators initiated by the industry since the accident. Its report appears in Chapter 4, including an addendum comparing the standards for employment of nuclear plant operators, airline pilots and air traffic controllers.

Material references in the studies is on file with the Senate Committee on Environment and Public Works. The reader may also find it helpful to refer to the report of the Special Investigation, *Nuclear Accident and Recovery at Three Mile Island*, for further details on the deficiencies addressed in these studies.

Part I

The Nuclear Regulatory Commission

Chapter 1

Changes in the NRC's Emergency Response Capability Since Three Mile Island

By

David E. Bucher and David D. Carlson

INTRODUCTION

The Special Investigation staff, as part of its investigation into the Three Mile Island (TMI) accident, examined changes made in the NRC's emergency response capability in the 15 months since the Three Mile Island accident. This subject is of particular concern given the serious deficiencies in the NRC's emergency response during the Three Mile Island accident. Various investigations and the NRC itself have suggested improvements in this area.

Based on a review of NRC and other documentation, interviews of NRC personnel, observations of a drill of the NRC's Operations Center,[1] and information provided by members of the public, this study examines and evaluates some of the changes that the NRC has made to its emergency response capability since March 28, 1979 and makes recommendations for further improvements. The problems evident in the NRC's emergency response at TMI are reviewed along with a summary of recommendations made by various investigations. A discussion of the NRC's role, as defined by the agency, its present emergency response organization, and site-related changes now being required of all licensees, follows.

The workings of the NRC's Operations Center and considerations of a Nuclear Data Link—a system for automatically transmitting data from the site to the NRC Operations Center—are discussed in detail. In the final section, conclusions and recommendations for resolving the shortcomings in the NRC's emergency response capability are presented.

THE NRC AND THE THREE MILE ISLAND ACCIDENT

The Nuclear Regulatory Commission was called upon to respond to an unprecedented situation during the Three Mile Island accident. Its response was very deficient, primarily because of poor planning and inadequate communications and organizational systems. The agency was unclear as to its role, and its relationship to the utility and to the State with respect to operational and protective action decisions was not well-delineated prior to or during the accident. Lacking clear guidelines, the NRC responded in an ad hoc manner, at times making suggestions to the licensee, at times directing that certain activities be halted, and finally recommending limited evacuation of the surrounding populace. (1)

The insufficiency of the NRC's response in part arose from the unanticipated nature of the events at Three Mile Island. Emergency response planning had been formulated on the assumption that an accident would progress rapidly and would be over before the agency had time to become involved. The agency was largely unprepared to respond to a situation in which it should provide guidance during an unfolding incident. (2)

Similarly, at the time of TMI, the decision-making process within the agency during an emergency situation was ill-defined. The Commissioners' role was unclear, as the response plans did not detail specific functions for them beyond the vague charge of providing "general policy which determines the overall course of action NRC takes in response to incidents." (3) Much of the Commissioners' time during the first day of the emergency was devoted to staff briefings on basic information and the TMI-2 plant status. The collegial body of the Commissioners contributed little to the resolution of the emergency.

The NRC's response was further hampered by blurred lines of authority between the Commissioners and the Executive Management Team (EMT). This second collegial body "transforms policy into specific guidance for the response organization and makes major decisions affecting NRC's response actions." (4) However, the EMT provided little guidance during the first day to the staff responding to the incident as part of the Incident Response Action Coordination Team (IRACT).[2] Moreover, interviews with Incident Response Center personnel by the Special Investigation staff suggest that the NRC's incident response organization and information flow to the EMT functioned as though there were two operational IRACTS consisting of representatives of the Offices of Inspection and Enforcement and Nuclear Reactor Regulation[3] respectively, with no single Technical Coordinator. (5)

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[1] See p. 20.

[2] The Incident Response Action Coordination Team (IRACT) was a group of senior NRC executives who comprised the operations arm of the NRC's emergency response organization. IRACT provided information, options and analyses to the NRC's Executive Management Team, which was located in an adjoining office of the Incident Response Center.

[3] See Appendix B, "Nuclear Regulatory Commission Organization," pp. 561ff., for a description of the offices within the NRC.

As the TMI incident moved forward, specialized teams of analysts supporting the IRACT group were involved in calculations and recommendations, including those surrounding the hydrogen bubble. Many of these calculations and recommendations were later found to be incorrect. (6) Similarly, although a regional team of inspectors was dispatched at the initiative of the Regional Director, and arrived onsite six hours after the initial event, the NRC did not fully understand the seriousness and nature of the accident for at least two days. (7) The onsite team provided little technical support during the first day of the accident, although it did serve for a while as a source of information to the State.

Facilities for emergency response both onsite and at NRC headquarters were quite limited. During the first day of the accident, the confusion in the control room was exacerbated by the congestion of utility and NRC personnel. A mid-morning evacuation of the Unit 2 control room forced both non-essential utility personnel out of the Unit 2 control room and NRC personnel arriving onsite into alternative Emergency Control Centers/Stations in the Unit 1 control room and the offsite Observation Center.

The NRC had designated the Incident Response Center[4] (now generally referred to as the Operations Center) on the third floor of the East-West Towers Building in Bethesda, Maryland, as the focal point of the NRC's monitoring and management efforts. John Davis, an EMT member from the Office of Inspection and Enforcement, activated the center soon after 8:00 a.m. upon learning from Region I personnel that the operator at TMI had declared a general emergency. The Special Investigation found repeated examples of incomplete and inconsistent information coming into and out of NRC headquarters during the first day of the accident. To a large degree this resulted from poor communications from the site and a confused, disorganized information flow within the NRC. Information was conveyed over a single telephone line from the site to regional and, later, headquarters offices during much of the first day. Information requests swamped the system, and information transmission was delayed, confused and sometimes wrong. Within the agency, the Incident Response Center was overcrowded and noisy. People had to shout to be heard. The planned internal communications system broke down, and information was transmitted in an ad hoc manner. (8) Again, information flow was neither timely nor always accurate. Press releases during the first day reflected this.

Given the lack of preparation for responding to such an incident, the poor flow of information and the ill-defined decisionmaking process, it is not surprising that the NRC's response to the accident was inadequate.

POST-TMI RECOMMENDATIONS

The most extensive recommendations on NRC emergency response to be published since TMI were issued by the Nuclear Regulatory Commission Special Inquiry Group. (9)

It recommended that the initial responsibility within the NRC following an incident be borne by the duty officer and then the Director of the Office of Inspection and Enforcement at the Operations Center in Bethesda. However, the Special Inquiry Group emphasized the importance of a strong NRC presence at the site. The onsite team, drawn from NRC Regional Office personnel and headed by the Regional Director, would be given the full authority of the agency after its arrival onsite. The team would be expected to monitor licensee activities, advise officials regarding protective actions and even direct the licensee if necessary. Meanwhile, the headquarters staff under the direction of a Commissioner or the Executive Director for Operations[5] would continue to provide technical support and would coordinate assistance for the onsite team. (10) The Special Inquiry Group stressed the need for improved data transmission and voice communication links between the site, the Region and headquarters. (11)

The National Academy of Public Administration (NAPA), under contract with the Special Inquiry Group, identified and evaluated alternative approaches to civilian nuclear reactor emergency management. The scope of its study involved more than just NRC emergency response, and its report (12) offers a valuable examination of overall emergency response and crisis management problems.

The NAPA report found that "The National Oil and Hazardous Substances Pollution Contingency Plan"[6] may serve as a good model for a nuclear crisis management system. (13) Suggested improvements included a community command, control and communications center; single-voiced preplanned media arrangements; a method for coordinating non-agency scientific advice during a crisis; and an NRC safety inspector in the control room at all times. Post-TMI changes reflect some of these recommendations. The report also identified 12 important principles from Army operations in civil emergencies, among them the need for a clarity of responsibility, good communications, flexibility in execution, effective public information, control centers, and priorities of purpose. (14)

---

[4] The Incident Response Center was the office for the NRC headquarters emergency response organization in Bethesda, Maryland. The agency's Incident Response Action Coordination Team (IRACT) and the Executive Management Team (EMT) worked out of adjoining offices in the Center.

[5] The Executive Director for Operations directs and coordinates the Commission's Operational and Administrative activities and the development of policy options for the Commission's consideration.

[6] A plan for coordinated Federal action to minimize pollution damage from discharges of oil and hazardous substances.

The Atomic Industrial Form Subcommittee on Emergency Response Planning [7] developed a model plan for emergency response by the nuclear industry. (15) It calls for four well-coordinated but independent emergency centers near the site, interconnected with reliable communications. (16) Many of the members of the Atomic Industrial Forum Subcommittee, including its chairman, were involved at TMI during April 1979 in conceptualizing and establishing the Metropolitan Edison/General Public Utilities Corporation [8] recovery organization. More recently, another Atomic Industrial Forum Subcommittee had been urging the NRC to integrate overlapping or inconsistent requirements of the several new safety concepts the NRC has been mandating or exploring. (17) (Some of these concepts—such as the Nuclear Data Link, the Technical Support Center and the Emergency Operations Facility—are discussed later.)

In the area of NRC emergency response, The President's Commission on the Accident at Three Mile Island discussed the historical development of various response organizations and critiqued the NRC's handling of the TMI emergency. The report noted a number of deficiencies in the overall emergency response at TMI and identified areas where improvement is needed. These included communications difficulties, the ill-defined role of the Commissioners, the low priority given to offsite radiological emergency planning, the inappropriateness of a collegial body as an emergency management tool, inadequate training at all levels and blurred lines of authority. (18) However, the President's Commission made no clear recommendations for upgrading the NRC's emergency response capabilities. (19)

A MITRE Corporation study of the perceived effectiveness of the NRC's response to TMI, based on interviews with 120 Federal officials, placed an emphasis on exploring the roles, needs and responsibilities of the Regional Office. It recommended that the initial assessment of an emergency be directed from the Regional Office whenever possible. (20)

THE NRC'S EMERGENCY RESPONSE CAPABILITY

Since the accident at Three Mile Island, the NRC itself has produced hundreds of pages of documents about emergency response. These reflect the modifications or additions made by various offices within the NRC in response to the recommendations of the groups mentioned above.

Each of the following subsections discusses post-TMI changes in NRC emergency response that have been implemented, as well as those that are still in the planning and developmental stages.

ROLE OF THE AGENCY

The NRC staff discussed the possible roles of the agency with the Commissioners in public meetings on February 6, 1980, and on May 15, 1980. As proposed at those meetings, the extent of the NRC's role would change as the incident became more severe. The spectrum of envisioned roles ranges from merely following the course of events during an accident to directing licensee activities or, conceivably, assuming management control of the facility.

According to the views of NRC staff members, in less serious events the NRC would simply monitor and evaluate plant status and licensee actions. (21) Victor Stello, Jr., Director of the Office of Inspection and Enforcement, explained one reason for monitoring an incident:

> A very important consideration . . . is the need to . . . consider collecting information so that we [the NRC] can respond to the public, to the Congress and [to have] information that is verified and can be released from the NRC with some measure of confidence of its authenticity. (22)

Monitoring an unfolding incident also permits the NRC response team to decide if greater agency involvement is warranted.

Based on their monitoring activities, the NRC staff members who are evaluating the unfolding incident would offer their engineering advice and judgments to the operators, with little restriction. Also, since the NRC has a responsibility to assure the protection of the public health and safety in the event of nuclear incidents, Stello states,

> . . . [t]he issue that must be kept in mind at all times is whether or not an emergency situation is developing where there is a need for the agency to make a recommendation for . . . protective measures. (23)

---

[7] The Atomic Industrial Forum is an industry group comprised of utilities, reactor manufacturers, architect-engineering firms, reactor component suppliers, nuclear service firms and other organizations. After the accident, several subcommittees were formed to address such topics as emergency response planning, operations systems and equipment, unresolved generic safety issues, post-accident recovery, safety analysis criteria, and control room considerations.

[8] The Metropolitan Edison Company (Met Ed) is the licensed operator for, and 50 percent owner of, the Three Mile Island Unit 2 nuclear powerplant. It is a wholly-owned subsidiary of General Public Utilities Corporation (GPU), a utility holding company that is the parent corporation of Met Ed, Pennsylvania Electric and Jersey Central, the three utilities that own Three Mile Island Unit 2.

The responsibility for making such recommendations to State or local officials lies primarily with the licensee. However, in response to an inquiry by the Special Investigation staff, the Commission stated:

> Within the context of its advisory role and based on its analysis of an actual accident situation, the NRC may deem it advisable that specific protective actions be recommended to appropriate State and local officials. (24)

The role of the Federal Emergency Management Agency[9] (FEMA) in such decisions has not yet been decided.

If the incident continues and the NRC becomes concerned that the "licensee is not taking appropriate action to protect public health and safety," the role of the agency would allow an authorized NRC person to issue a directive or order to the licensee to modify the course of action taken by the licensee. (25)

Finally, the Commission reserves the right in extreme circumstances to assume management control of the operations of the plant. However, the staff and Commissioners agree that this function would never take place from the Operations Center in Bethesda, but rather would be done by authorized NRC personnel onsite, and that this function would be limited to management, not actual "hands-on" control of the facility. (26) That is, the NRC would make decisions as to the strategy to be pursued in coping with the accident, but actual operation of the plant would be done by the licensee.

The Commission, in a June 2, 1980 memorandum, provided the staff with guidance regarding its view of the agency's role. The memo states:

> While the possibility that the NRC might have to assume the roles of direction and management control cannot be ruled out, the Commission believes that such situations will be rare. For planning purposes, the Commission directs the staff to assume that the NRC role will be limited to monitoring and advisory for 98 percent of the time, with 2 percent of the weight given the direction or management control roles. (27)

Some industry representatives are extremely wary of the possibility of strong NRC intervention, such as a direction or management control role. They acknowledge, however, the need for the NRC to be informed of unfolding developments in an accident. (28)

One representative of a group opposed to nuclear power, on the other hand, desires a stronger role for the NRC in response to an emergency. This is based on a view that the utility's actions may be influenced by factors other than protection of the public's health and safety. (29)

COMMAND ORGANIZATION AND PERSONNEL

Several units of the NRC are involved in response to an emergency. Both headquarters and regional personnel respond, and, within headquarters, several offices are called upon. Figure 1 shows the NRC's incident response organization. (30)

While the Commissioners and their staffs are located in downtown Washington, D.C., the bulk of the NRC personnel are scattered among a half dozen buildings in Bethesda and in other buildings in Silver Spring and Rockville, Maryland. The East-West Towers Building in Bethesda, in which the NRC Office of Inspection and Enforcement has several floors, houses the emergency Operations Center. During an emergency, this immediately becomes the focal point of the NRC headquarter's incident response.

The NRC, like most Federal agencies, has divided the United States into five geographical regions, each with a Regional Office headed by a director. Upon activation of the headquarters' Operations Center, the appropriate regional director is dispatched to the site with a predesignated team, sometimes referred to as the "regional" or "onsite" team. Each regional office has its own incident response center whose activation and continued monitoring of an incident has thresholds which differ from those at headquarters.

With the growth of the Resident Inspector program—a program in which an NRC inspector will be assigned to each operating nuclear plant—the first NRC presence at the site following an incident will likely be that of the onsite inspector.

COMMISSIONERS

The experience of the five-member Commission during the TMI incident raised questions as to the ability of a collegial body of five equal members to manage an unfolding incident. (31)

Under current NRC emergency procedures, the Chairman or a Commissioner designated by the Chairman will be the head of the NRC's Executive Management Team (EMT) during an incident. (32) The procedures contain no specific assignments for the other four Commissioners. The NRC reorganization plan, to take effect in October 1980, will transfer "to the Chairman all the functions vested in the Commission pertaining to an emergency. . . ." This would include "the functions of declaring, responding, issuing orders, determining specific policies, advising the civil authorities and the public, directing and coordinating actions relative to such emergency incident." (33) Current procedures would appear to be consistent with the proposed reorganization, with the Chairman or his designee clearly in charge of the agency's emergency response. This represents a great im-

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[9] The Federal Emergency Management Agency was formed to coordinate Federal response to emergencies.

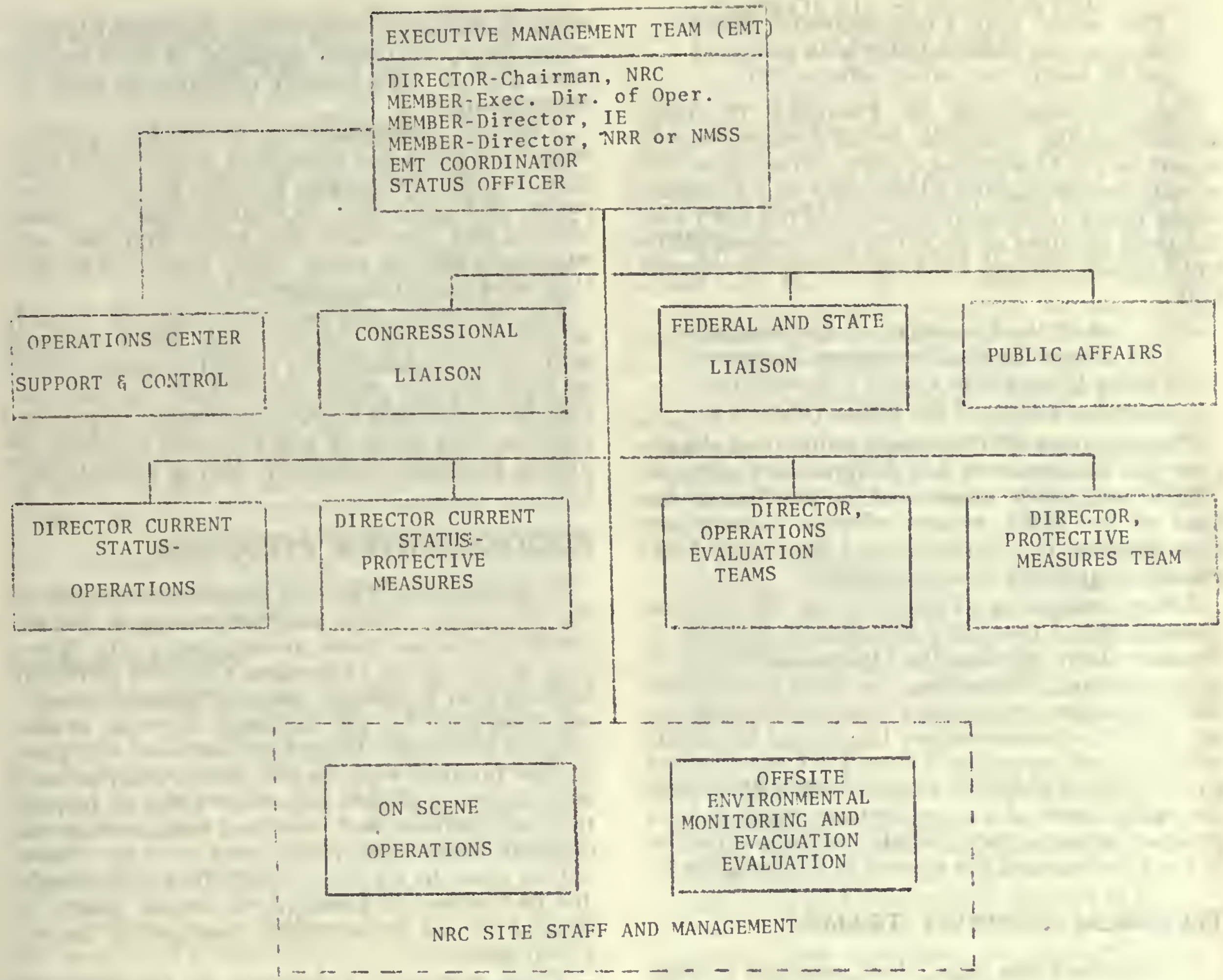
EXECUTIVE MANAGEMENT TEAM (EMT)
DIRECTOR-Chairman, NRC
MEMBER-Exec. Dir. of Oper.
MEMBER-Director, IE
MEMBER-Director, NRR or NMSS
EMT COORDINATOR
STATUS OFFICER
OPERATIONS CENTER SUPPORT & CONTROL
CONGRESSIONAL LIAISON
FEDERAL AND STATE LIAISON
PUBLIC AFFAIRS
DIRECTOR CURRENT STATUS-OPERATIONS
DIRECTOR CURRENT STATUS-PROTECTIVE MEASURES
DIRECTOR, OPERATIONS EVALUATION TEAMS
DIRECTOR, PROTECTIVE MEASURES TEAM
ON SCENE OPERATIONS
OFFSITE ENVIRONMENTAL MONITORING AND EVACUATION EVALUATION
NRC SITE STAFF AND MANAGEMENT

FIGURE 1.—NRC Incident Response Organization.

provement over the situation which existed at the time of the Three Mile Island accident.

EXECUTIVE MANAGEMENT TEAM

During an event at an operating reactor requiring activation of the Operations Center, the Executive Management Team (EMT), consisting of the Chairman or a designated Commissioner, the Executive Director for Operations, the Director of the Office of Inspection and Enforcement and the Director of the Office of Nuclear Reactor Regulation, assembles and is in charge of the NRC's emergency response actions and resources.

In support of the EMT, members of the NRC staff assemble under the direction of various Technical Staff Directors. Liaison between the EMT and the technical staff is provided by a senior staff person known as the "EMT Coordinator." This position was formalized since the TMI accident to ensure coordination and scheduling of technical briefings for the EMT members. An EMT "status officer" has also been designated from among senior NRC staff to brief high-level officials in Congress, Federal agencies and the State government.

The relationship between the EMT and the Commissioners has been better defined since TMI. In a memorandum dated February 7, 1980, Edward Hanrahan of NRC's Office of Policy Evaluation, presented four options for Commissioner discussion. (34) The third of these options proposed that the Chairman (or another designated Commissioner) be head of the EMT:

> This option would put the chief executive officer of the agency (or his delegated colleague) in charge of the agency's emergency response. This would be consistent with normal management conditions and would place at the head of the response organization someone with the authority to require and assure integrated and coordinated actions by the various staff organizations. But, it is questionable whether the Chairman (or designated Commissioner) would have technical capabilities relevant to the emergency.

> The other four Commissioners would have no role in an activity with potential public health and safety effects. (35)

The Commissioners, on February 19, 1980, agreed that the Chairman or his designee should report to the Operations Center. After some discussion concerning the advisability of a Commissioner being the unequivocal head of the EMT and the need for lines of authority and responsibility to be clearly defined, the Commission also agreed that

> . . . when the Chairman or his designee [is] present in the Emergency Response Center [Operations Center], he would assume leadership of the EMT. (36)

The proposed NRC reorganization plan clearly puts the Chairman or his designee in charge of NRC's emergency response. His position as the head of the EMT assures effective communications between the Chairman and the senior NRC officials responding to an emergency.

After notification of an incident, the first responsibility of the EMT members is to make a decision about whether the Operations Center is to be activated. Thereafter, the EMT coordinates NRC activities and makes major decisions affecting NRC's response actions. The role of the EMT, which has not been altered since TMI, ensures that any important decisions made by the NRC during the early hours of an incident are reached by a group of senior agency officials under the direction of the Chairman of the agency or his designee.

TECHNICAL SUPPORT TEAMS

During the Three Mile Island accident, a group of senior agency officials known as the IRACT provided technical support to the EMT. This body no longer exists. Instead, the technical staff is divided into two major groups—an Operations group and a Protective Measures group (see Figure 1). Each of these major groups is further subdivided into two teams according to their focus. One team, made up largely of Office of Inspection and Enforcement personnel, looks at current plant status, while the second, comprised primarily of Office of Nuclear Reactor Regulation staff, concentrates on long-term evaluation and prognosis. These four "technical support teams" analyze incoming data, look for trends and speculate as to future events. Each has a director who reports directly to the EMT at the request of the EMT coordinator.

This four-part division of the Operations Center technical staff represents an improvement over the response organization during the TMI incident. While the composition of the IRACT groups during TMI was not radically different from these four groups, this conceptualization provides a sharper focus for the various teams and their technical support directors.

The technical support directors do not function as a deliberative body and do not have a single director as did the old IRACT. They tend to move around the center and exchange information. The recent installation of electronic status boards provides for a continuous exchange of data among these groups, with broadly overlapping areas of responsibility.

Although conceptualized as distinct groups, reports of drills and actuations of the center suggest that the distinctions between the short-term status and long-term evaluation teams become blurred and that these two teams find they are working together much more closely than the theoretical structure suggests. (37)

The key support people on each team are located in the Operations Center, while the remaining staff and those detailed for special projects remain in their regular offices. Individuals are selected largely on the basis of their knowledge of and experience with accident and transient behavior in plants, and their composure during emergencies. (38)

REGIONAL OFFICE PERSONNEL

In general, the NRC can gather its resources at the Operations Center long before any of the regional people can reach an emergency site. However, as soon as the Operations Center is activated following an incident, a cadre of regional personnel supervised by the Regional Director is dispatched to the site. Many team members will have become familiar with the site during their normal assignments as project inspectors. Office of Inspection and Enforcement personnel estimate that the regional teams can reach most nuclear plants within three to six hours. (39) This is primarily due to the remote locations of nuclear plants in relation to the major urban locations of the regional offices.

Those personnel remaining at the Regional Office continue to play a supportive role since they will usually be more familiar with the particular facility than their counterparts at headquarters. They will be kept abreast of the incident through the same communications network (discussed later) which serves as a channel from the site to the Operations Center.

Onsite Teams

Once the onsite team arrives at the plant, it must ascertain the status of the accident. In understanding what has transpired and in dealing with the situation thereafter, the team will have the definite advantage of being on location—an important point realized by personnel involved in the TMI response.

Pre-TMI emergency planning did not assign a significant role to the Regional Director. A greatly enhanced role for the Regional Director as the senior NRC official at an emergency site was strongly recommended by the NRC Special Inquiry Group. (40) The EMT intends to shift the responsibility for managing NRC's response to the Regional Director and his onsite team. This transfer of authority, however, is not automatic but depends on the type of incident. Such a transfer of authority would occur once the EMT is assured that the Regional Director is fully informed and capable of dealing with the situation. (41) It should be noted, however, that this role was not part of the job description when current Regional Directors were chosen. Thus, all may not be equally qualified to perform this function.

There is no guidance on when such a transfer of authority would occur. Rather, it is strictly an ad hoc decision made by the EMT based on its judgment as the incident unfolds. The NRC Special Inquiry Group recommended that this shift occur as quickly as possible. (42) During the Crystal River incident, it did occur when the Regional Director arrived and was fully apprised of the situation. Shortly thereafter, with authority in the hands of the Regional Director and with the incident pretty much over, the EMT disbanded, with the Operations Center continuing in a monitoring and support role through the night. (43) Victor Stello indicated that shifting authority for making NRC decisions to the site at some point in the incident would be the norm. However, if an incident were prolonged and severe enough, rather than transferring authority to the site, a team, possibly including an EMT member, would be dispatched from headquarters. (44)

Resident Inspectors

In a memorandum to the five Regional Directors, dated March 14, 1980, Victor Stello included an Incident Response Guidance outline for Resident Inspectors. (45) He points out that "the licensee is responsible for informing the NRC Operations Center promptly of significant incidents" and must provide a continuous communicator on the open line. (46)

During an incident, the NRC Resident Inspector serves as an additional set of onsite "eyes and ears." (47) Immediately following an incident, the—

> actions of the resident inspector should be directed toward obtaining the details of the incident (both equipment performance and operating actions), assessing the safety significance of the event and determining licensee action plans. (48)

He can communicate these to the field communicator at the Operations Center over the telephone.

The Resident Inspector has a checklist detailing operational and radiological concerns, followed by a listing of important parameters of concern to the NRC. He is to be acquainted enough with his role and checklist so that he responds quickly during an incident.

The Resident Inspector will raise any serious concerns with headquarters' personnel or the regional response team once it arrives onsite. If the incident rapidly becomes severe, the Resident Inspector may advise headquarters of the need for recommending protective actions. While the Resident Inspector is free to question the licensee's actions and offer his best engineering judgment, he is not delegated the specific authority to issue directives to the licensee. (49)

IMPROVED SITE-RELATED CAPABILITIES

Both the NRC and the licensee recognized at TMI that the noise and confusion of a congested control room may hinder effective emergency response. This has led the Office of Nuclear Reactor Regulation to mandate several other facilities for all operating reactors, each with a particular purpose. All licensees are aware of these mandatory centers with their respective deadlines. However, the requirements and details for the centers, as described in letters of September 13 and October 30, 1979, are still quite vague. (50) (51)

The first of these centers, the Onsite Technical Support Center, reflects the desirability of having operations-oriented personnel located in an area "separate from and in close proximity to the control room." (52) This center would provide a place—

> in close communication with the control room so as to have sufficient knowledge of current and projected plant status, for management and technical personnel to support reactor control functions, to evaluate and diagnose plant conditions, and for a more orderly conduct of emergency operations. (53)

The Technical Support Center is to have—

> the capability to display and transmit plant status to those individuals who are knowledgeable of and responsible for engineering and management support of reactor operations in the event of an accident. Upon activation in emergencies, this facility will provide the main communications link between the plant, the Operational Support Center,[10] the nearsite Emergency Operations Facility [11] and NRC. (54)

Accordingly, the Office of Nuclear Reactor Regulation required all licensees to establish an operational Onsite Technical Support Center for each operating nuclear power plant by January 1, 1980. (55) Although each reactor site now has designated a Technical Support Center, their equipment ranges from telemetry, computer displays and closed circuit televisions scanning the control room, at some reactor sites, to a room with a telephone extension on the control room operations line, in others. (56) By January 1, 1981, the centers' capacities must be upgraded from the initial requirements to more sophisticated, reliable and habitable centers. (57)

Licensees have also been informed of the specifications of the Nuclear Data Link, discussed later, which is still under consideration. (58) These specifications presumably will be taken into consideration in the development of their technical support centers. However, requirements for data to be made available in this center have not yet been decided. Stello of the Office of Inspection and Enforcement suggests that the amount of data that ought to be available in the Technical Support Center is a controversial issue deserving of more study. (59)

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[10] Discussed below.
[11] Discussed below.

A second center required by the NRC is an onsite Operations Support Center. The TMI accident demonstrated that there is a need to restrict access to the control room to only those people requested to be present by the person supervising reactor control activities.

> The operational support center is to be established separate from the control room as a place in which operations support personnel assemble and report in an emergency situation to await instructions from the operating staff. [It] is to be provided with communications with the plant control room, Technical Support Center, and the near-site Emergency Operations Facility. (60)

The final required center is the near-site Emergency Operations Facility. This facility, located near the plant but offsite, would receive communications from the plant and the plant's health physics office and would serve as a "planned, organized central focal point for coordination of onsite and offsite activities for reactor emergency situations." (61) This center would provide a centralized meeting point for key representatives of Federal, State and local agencies and would make available information regarding current and projected plant status; it should enhance the ability of officials to contribute logistical support to the onsite operations. It is expected that discussions and decisions regarding the need for protective actions would take place in this center. Press facilities would be available to disseminate information to the public.

Many licensees already have appropriate facilities or will be constructing them. Emergency Operations Facilities, required to be operational by January 1, 1981, could in many cases be based at existing police, fire or community facilities. At least one major utility plans to construct a new unit; it sees existing public facilities merely as back-up centers in case its center becomes uninhabitable. In addition, in non-emergencies it could be used as a training center equipped with a control room simulator. (62) As eventually upgraded, the Emergency Operations Facility could be linked to the plant parameters available in the Technical Support Center, although the NRC has not yet established requirements in this regard. The Office of Nuclear Reactor Regulation will establish criteria for the data link of the facility with the control room and/or Technical Support Center; these criteria must be coordinated with the work on the NRC Nuclear Data Link. (63). This facility will be equipped for communications with the Technical Support Center, NRC, the reactor-vendor and others.

NRC HEADQUARTERS OPERATIONS CENTER

The focal point for the NRC's headquarters emergency response is the Operations Center. Consisting of two large rooms and several surrounding satellite offices, it is situated on the third floor of the East-West Towers Building in Bethesda—a half-hour drive from downtown Washington. The Executive Management Team (EMT) will assemble in one of the large rooms, where it will receive briefings and manage the NRC's response until delegating this responsibility to the onsite team.

The EMT room is outfitted with a large central accumulation of tables, speaker phones, television screen, charts, maps, a library, overhead projectors, intercoms, etc. A wall with a door and a large glass window separate this room from the Operations Room which housed the IRACT during the TMI incident. During the TMI incident, the continual cacophony in the Operations Room detracted from effective discussions. Accordingly, the room has been increasingly dedicated to communications alone. Phone lines from each site terminate in the duty officer's station in this communications room. Once an incident begins, operations and radiological communicators maintain the NRC end of the open lines to the plant in this room as well.

As noted, IRACT's functions in an accident have been taken over by four technical support directors and their technical support teams. Current NRC planning assigns the technical support directors and their key support staff to the outlying satellite offices, displacing many of the regular occupants of these rooms.

Dispersing the technical support teams to satellite offices has the effect of reducing noise and confusion in the communications room but creates additional communications and coordination problems. To address this latter problem, the perimeter rooms have been outfitted with telephones, intercoms and electronic blackboards (pressure-sensitive blackboards which pick up the imprint of a chalk stroke and display the impression on three different closed circuit televisions) to provide a better flow of information from the communicators with the site to the technical support teams, among the four teams, and to the EMT.

Because the satellite offices are really too small to meet the needs of the technical support directors and their key team members effectively, the Office of Inspection and Enforcement, along with the NRC's Office of Administration, has been trying to redesign the third floor of the East-West Towers to provide layout more conducive to the current emergency response structure. Additional space and larger rooms will permit more key support personnel to relocate from their offices in the other Bethesda buildings and should relieve the cramped conditions now facing the various teams.

All operating nuclear powerplants now have a telephone line which can only be used to communicate from the control room(s) at each site to the Operations Center in Bethesda. Should any of 12 types of events, listed in a new amendment to the NRC's regulations and covering a wide range of actions occur, the licensee must immediately report the event to the Operations Center over this dedicated telephone.[12] Whenever someone at any site picks up the receiver on the dedicated phone, the switchboard telephone automatically rings at the Bethesda duty officer's station. A matrix panel next to the switchboard has small lights which indicate immediately which facility initiated the call.

The Office of Inspection and Enforcement has plans to replace these several components with a completely new console. Although there is currently a conference-call capability, the new console would increase the ease and reliability of linking up the Operations Center with the regional office, personnel knowledgeable in the plant's design and operation at the architect-engineering firm and the reactor-vendor, and other experts.

The Operations Center is staffed 24 hours a day with NRC duty officers. These are senior level engineers drawn from the Offices of Nuclear Reactor Regulation, Inspection and Enforcement, and Nuclear Regulatory Research, most of whom have considerable experience with reactor systems.

Most of those chosen for this assignment are on duty for a week-long shift once or twice a year. A general training session provides all duty officers with a conceptualization of their role in the response organization. A second session is repeated for each weekly group of officers to familiarize them with the procedures and equipment they will routinely use at the center and be forced to utilize during an incident. The emphasis of the training is on turning these highly qualified engineers into effective communicators. E. Morris Howard of the Office of Inspection and Enforcement has proposed the use of professional "communicator-types"—retired military sergeants or civilian air traffic controllers. This would place greater emphasis on the duty officers' continued effectiveness and unflappability during an emergency and much less on their technical background. (64) Conversely, Stello feels the most important elements for duty officers are technical competence and understanding. (65)

ACTIVATION OF THE CENTER

Upon notification of an event over the dedicated operations phone line, the duty officer completes the appropriate initial notification form—a "Significant Event Report." To do this, the duty officer will need to obtain from the licensee a description of the event, the consequences of the event, the cause of the event and any corrective actions the licensee has taken. The licensee does not have a copy of this form but would be expected to know the required information. (66)

During normal working hours the duty officer is instructed to contact the appropriate Inspection and Enforcement Division Director, predicated on the type of incident, and pass along his information. The Division Director filters out the insignificant from the serious events. In some cases, however, the duty officer may speak directly with a nearby Executive Management Team member, e.g., Stello, thereby avoiding the intermediary.[13]

There are no clearly defined criteria for activation of the Operations Center; rather it is a matter of judgment. (68) If the determination is reached that the incident involves relatively insignificant effects, notification will proceed no further. On the other hand, if the event is deemed to be serious, the Division Director will contact the first available EMT member or alternate, will recommend activation of the Operations Center and will pass along the information supporting his recommendation.

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[12] **10 CFR § 50.72 Notification of significant events.**

(a) Each licensee of a nuclear power reactor licensed under § 50.21 or § 50.22 shall notify the NRC Operations Center as soon as possible and in all cases within one hour by telephone of the occurrence of any of the following significant events and shall identify that event as being reported pursuant to this section:

(1) Any event requiring initiation of the licensee's emergency plan or any section of that plan.

(2) The exceeding of any Technical Specification Safety Limit.

(3) Any event that results in the nuclear powerplant not being in a controlled or expected condition while operating or shut down.

(4) Any act that threatens the safety of the nuclear powerplant or site personnel, or the security of special nuclear material, including instances of sabotage or attempted sabotage.

(5) Any event requiring initiation of shutdown of the nuclear powerplant in accordance with Technical Specification Limiting Conditions for Operation.

(6) Personnel error or procedural inadequacy which, during normal operations, anticipated operational occurrences, or accident conditions, prevents or could prevent, by itself, the fulfillment of the safety function of those structures, systems, and components important to safety that are needed to (i) shut down the reactor safely and maintain it in a safe shutdown condition, or (ii) remove residual heat following reactor shutdown, or (iii) limit the release of radioactive material to acceptable levels or reduce the potential for such release.

(7) Any event resulting in manual or automatic actuation of Engineered Safety Features, including the Reactor Protection System.

(8) Any accidental, unplanned, or uncontrolled radioactive release. (Normal or expected releases from maintenance or other operational activities are not included.)

(9) Any fatality or serious injury occurring on the site and requiring transport to an offsite medical facility for treatment.

(10) Any serious personnel radioactive contamination requiring extensive onsite decontamination or outside assistance.

(11) Any event meeting the criteria of 10 CFR § 20.403 for notification.

(12) Strikes of operating employees or security guards, or honoring of picket lines by these employees.

(b) With respect to the events reported under subparagraphs (1), (2), (3), and (4) of paragraph (a), each licensee, in addition to prompt telephone notification, shall also establish and maintain an open, continuous communication channel with the NRC Operations Center, and shall close this channel only when notified by NRC.

[13] Stello's office is very close to the duty officer's station in the Operations Center. During the Crystal River incident, where notification occurred around 3 p.m., Stello was involved immediately. Based on a twice-verified but incorrect containment pressure of 18 psig and a reading of 50 roentgen on the containment dome monitor, he decided within minutes of notification to activate the Center. (67)

The EMT member makes the decision to activate the center. The intermediate step of notifying the Division Director is justified by the fact that the reporting system requires that even minor incidents be reported. (69) Hence, many of the notifications involve relatively insignificant problems not necessitating the attention of the EMT members.

During non-office hours, the duty officer locates the designated Inspection and Enforcement staff member on his call list and relays the information he has. This senior Inspection and Enforcement person serves the same function as the Division Director during normal working hours.

Once the decision to activate the Operations Center has been made, notification of essential personnel whose names appear on the call lists begins immediately. This will result in the convergence on the Center of 60 to 100 persons within minutes or an hour or so, depending on the time of the day and the severity of the incident. Although there is only one level of Operations Center activation, if persons are not certain about the seriousness of the incident, a group of 10 to 12 persons may assume a "stand-by" status. During this time, more information will be obtained through continued monitoring, and the decision of whether or not to activate the Center will be made. During the year since the TMI incident, the Center has been placed on standby six times. (70)

The Operations Center is but one of the NRC tentacles thrust into action following such an alert. The NRC incident response plan also requires that the inspection force in the Regional Office be alerted to the incident very early in NRC's emergency response. (At the time of the Three Mile Island accident, the licensee was required to notify only the Regional Office of problems at the plant. Now, however, the licensee notifies headquarters, and then headquarters personnel notify the Regional Office.)

Upon notification of an incident, the duty officer at the Operations Center, with the assistance of the on-call designated Inspection and Enforcement staff member, assesses the severity of the incident. If the incident is viewed as an actual or potentially serious threat, the Region is notified immediately. If the incident is viewed as less serious but the Operations Center duty officer continues to have doubts about its significance, he may initiate a conference call with Regional and headquarters contacts to discuss his questions or concerns.

Upon notification of the activation of the headquarters Operations Center, the Regional Director, with his selected cadre of Regional Office staff members, forms a team and departs for the site. The size and composition of the team varys depending upon the type and severity of the accident. Information about the incident relayed to the Region will help the Regional Director select the appropriate team members.

RECEIVING DATA FROM THE PLANT

Currently, the most vital links between the ailing facility and the NRC nerve center are two telephone lines. The first one, as described previously, is the reactor operations hotline from the control room to the Operations Center. The second and more recent installation is dedicated to radiological information. This system, known as the Health Physics Network, has circuits connecting the plant's health physics office to the Operations Center through the regional offices. It has some small problems which the Office of Inspection and Enforcement is still trying to eliminate, although the system would be expected to be operational in event of an incident. (71)

Several persons on both the operations and radiological teams have been designated as NRC's field or external communicators. The first person so-designated to arrive at the Operations Center from each of these teams takes over from the duty officer the vital function of communicating with the site. These communicators are scientists or engineers who, it is anticipated, can develop a quick rapport with the person manning the site phone—either the utility communicator or the NRC's resident inspector. (72) Communicators remain on their respective lines to the facility continuously until the Operations Center is de-activated.

Although initially the duty officer has been instructed to use a general "Significant Event Report Form," there is no predetermined checklist for the communicator to work from to obtain and update plant parameters. Rather, the technical support directors, upon reaching an understanding of what type of event is unfolding, are expected to develop a list of questions that the communicator can repeatedly ask his onsite contact. (73) According to E. Morris Howard:

> . . . you cannot define [in advance] each incident or accident. So you just have to play it by ear to find out what it is and what is going on. Then you ask the questions that are pertinent to that aspect of it. (74)

The field communicator in the Operations Center is responsible for updating the selected parameters periodically, if not continuously. This permits the technical staff to stay abreast of current reactor status and to formulate longer term evaluations.

One of the most severe problems during the first day of the Three Mile Island accident was obtaining accurate information from the site. Two problems were evident from the investigations of the accident: the difficulty of establishing and maintaining reliable telephone communications; and the lack of timely, accurate transmittal of information. The installation of dedicated phone lines will help alleviate the first of these problems. It appears, however, the information flow could well remain a problem without a better system to structure communication of information, such as a data list for both the licensee and the NRC communicator to work from.

KEEPING OPERATIONS CENTER PERSONNEL INFORMED

The investigation of the Three Mile Island accident conducted by the Special Investigation demonstrated that the flow of information within the Incident Response Center was anything but optimal. Since the Three Mile Island accident, the NRC response organization has been more clearly defined, and more emphasis has been placed on identifying and training the appropriate persons, including the duty officers, various communicators, technical support teams and their directors and several components of the EMT. In addition, the communications hardware of the Center has been upgraded to include more intercoms, remote speakers for telephones, lighter headsets, and electronic blackboards.

As discussed above, from the time of notification of a severe event, data comes into the Operations Center over dedicated telephone lines where it is received by field communicators. Information is relayed to the technical support teams via an internal communicator who runs information between the communicator in the communications room and the teams in their satellite offices. Alternatively, the teams in the satellite offices can hear the conversations between the site and the Operations Center communicator over a speaker phone in their offices. The technical support directors relay requests to the communicator via the internal communicator or may talk directly with the communicators' desk by way of tabletop intercoms.

The electronic status boards, updated by support team personnel whenever new information arrives, have input to TV monitors in the EMT room and the offices of the complementary support teams. These permit support teams to become aware immediately of status updates from the site and information known to their counterparts on the other teams. The operations television monitor in the EMT room keeps EMT members informed and alleviates the need for them to wander into other offices. Any significant change in plant status will be known by the EMT members, and they may question the technical support directors during periodic briefings arranged by the EMT Coordinator.

While the hardware improvements, particularly the electronic blackboards and TV monitors, represent significant improvements to internal Operations Center communications, the "runner system" for relaying data and requests between the communicator and the technical support teams remains a weakness in internal communications. During the TMI accident a similar system for relaying information between IRACT and the EMT quickly broke down and was a serious deterrent to the reliable transmission of information within the Response Center. (75) This weakness may be resolved if the NRC implements plans to move the communicators into the offices of the technical support team. (Implementation of this, however, would create a noisy environment for both the communicator and the support teams.)

As the accident unfolds, the technical teams and the EMT will likely seek information on parameter trends to allow an assessment of possible future accident events. However, since the electronic blackboards have no storage capability, they can provide only the latest status information. The NRC has arranged to produce such trends through use of a National Institutes of Health computer. By periodically entering the current status of various parameters manually into the computer, trends may be compiled and retrieved upon request from several terminals. The desire for instant retrieval and trending of data is one of the driving forces behind the Nuclear Data Link, discussed later.

DECISIONMAKING

Much of what passes for "advice" to the licensees (e.g., Have you thought of doing this?) falls short of that elevated orbit known as "decisionmaking." Operations Center personnel will be in continuous communication with the licensee or the NRC representative onsite. While the technical support directors will usually relay questions through the Operations Center communicators, they may directly question the site communicator as to whether the operators have considered a certain diagnosis of the incident or a particular alternative action. According to Stello:

> [T]hat goes on all of the time. The people who are evaluating [the incident], as they see things unfold[ing], will inevitably ask the licensee if he has considered a number of alternatives or he might wish to look at whatever, those kinds of words are generally passed on by just about everyone . . . There is very little restriction in terms of passing on engineering advice and judgment. (76)

This proffering of advice by the NRC could be viewed merely as one side of two-way discussions between the utility and the regulator. The licensee's engineers could discuss events via an extension of the operations telephone line.

Until delegated to NRC personnel onsite, the NRC's most important decisions during an incident are made by the Executive Management Team, a team consisting of some of the most senior NRC managers and policymakers. Incident response planning discourages their listening in or talking on the operations hotline (although they have that capability), preferring that they not deal with "unevaluated data" but rather that they receive evaluations from the technical support directors.[14] (77) Hence, the quality of the EMT decisionmaking is dependent on timely and succinct briefings from its technical support directors.

The range of decisions facing the EMT may include recommending protective actions to the appropriate State authorities, delegating authority to the Regional Director onsite and requesting assistance from other organizations. In addition, the

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[14] The EMT members, however, do receive raw data over their TV monitor from the electronic status boards.

Commission has included the possibility of the NRC issuing directives to the licensee during nuclear emergencies as part of the NRC's role. Staff members on the EMT recognize that under unusual circumstances they may issue a directive to an operator whom the NRC determines to be pursuing an inappropriate course of action. (78)

Following an EMT decision to order the licensee to take a prescribed action, the directive would be relayed over the operations hotline directly from the EMT. Presumably, it would then be passed along to the utility's onsite emergency director by way of the utility communicator, although the emergency director could be called to the phone in the control room or to one of the extensions in one of the required on- and near-site centers. Furthermore, utility management personnel located at their corporate headquarters or elsewhere could easily hold a conference call over the operations line for such a directive.

If the need for such a directive arises after the arrival onsite of NRC's regional team, the authority to issue directives may be delegated to the Regional Director, or at least the directive issued after consultation with him. The Regional Director, if he is not in the control room, would be able to communicate the directive telephonically from the onsite Technical Support Center.

Protective action recommendations constitute perhaps the most important decisions to be made during an emergency. While the licensee is primarily responsible for making such recommendations to State and local authorities, the NRC may also make protective action recommendations should it deem them advisable. Such decisions would be made on the basis of radiological dose guidelines set forth by the Environmental Protection Agency and a consideration of current and projected plant conditions. (79) The radiological thresholds for protective action are well-established, and decisions based on these would involve a comparison of releases to the guidelines. Specific plant conditions requiring protective action are not yet delineated and would vary greatly depending on the situation.

A joint NRC/Federal Emergency Management Agency document providing guidance for the preparation of emergency response plans (80) outlines four classes or levels of emergencies: notification of unusual event, alert, site emergency and general emergency. Examples of each type of event are provided in the document, and actions to be taken by the licensee and the State and/or local authorities are delineated. However, uncertainty about actual plant conditions, an important factor in the TMI accident, is not explicitly addressed in the document.

The document, which was issued for interim use and comment, could serve as a basis for considering plant conditions in making protective action decisions. However, when an EMT member was questioned regarding guidance for considering plant conditions in making protective action decisions, he did not mention this document, but rather indicated that such decisions would be based upon the EMT's judgment. (81) Another EMT member discussed these classes in terms of the licensee's response, but did not relate them to an EMT decision regarding a recommendation for protective action. He did, however, state that the EMT would attempt to determine whether the licensee had assigned the appropriate action level to the incident. (82)

During the first hours of an incident, such important decisions would be made by the EMT from the Operations Center, probably following consultation with the licensee. The difficulty of making decisions from afar, however, is recognized by persons involved with the response during TMI. Consequently, the EMT may delegate the decisionmaking role to the onsite team headed by the Regional Director once it has arrived. A decision regarding recommending protective action would undoubtedly then be made in consultation with utility personnel and headquarters staff.

Although the reactor-vendor and architect-engineer representatives onsite or at their corporate headquarters may have valuable information and expertise worth tapping in an emergency, their potential involvement is not reflected in any of the incident response procedures. The capability exists for including them in conference calls with the licensee and headquarters, but little consideration appears to have been given to this sort of arrangement. Stello expressed reservations about the idea of including the reactor-vendor or architect-engineer if they were not fully informed of current plant conditions. (83)

SHIFT OF FOCUS TO THE SITE

Those individuals who were involved with the NRC response to the TMI accident and subsequent investigations have agreed on the difficulty of providing advice and direction to the plant operator from a command center in Bethesda. For example, the NRC Special Inquiry Group stressed the importance of getting people onsite as quickly as possible after a significant incident. That group recommended a strong NRC presence in the form of a regional team under the direction of someone with the clout of the Regional Director. (84)

In form, at least, the NRC's current incident response organization reflects this concern. As noted, an NRC team directed by the Regional Director is automatically dispatched from the Region immediately upon activation of the Operations Center. This provides the opportunity to shift the focus of the NRC's response efforts to the onsite team after the team members have had an opportunity to understand the accident sequence and current status.

In memos to each Regional Director, dated April 22, 1980, the Commission officially delegated limited authority to the Regional Directors to issue orders to licensees during an emergency. (85) During an incident, the Director of the Executive Management Team in Bethesda shifts the focus to the site when the EMT determines it is appropriate to transfer control of NRC actions and resources to the Regional Director. Specific guidelines for this determination have not been established.

Such a transfer of authority took place during the Crystal River incident. The Operations Center was activated at 2:50 p.m.—soon after the incident began—and the Regional Director, who happened to be in Washington at the time, and his team departed for the site. The Regional Director arrived about 9 p.m. The EMT continued to retain full NRC authority at headquarters until 10:22 p.m., at which time the EMT delegated authority to James P. O'Reilly, the Region II Director in charge of the onsite team. The EMT members then dispersed, although the Operations Center continued to provide support to the onsite team. By this time, however, the incident was essentially over.

In the absence of any guidelines, it is still not certain that the EMT would relinquish authority during a continuing incident. Victor Stello, however, asserts:

> When the Regional Director gets there and gets up to speed, it is the intent that he will have that authority, and it has nothing to do with whether or not the incident is over . . . but the first thing I'd want to know from [him] is, "Is he comfortable? Does he feel that he does not have enough of an understanding or enough people, and wants to hold back for awhile . . ." It pretty much depends, I think, to some degree on him. (86)

MEDIA RELATIONS

In event of an incident at a reactor, one important function performed by the NRC is keeping the public informed through communications with the media.

Upon activation of the Operations Center, the Director of the Office of Public Affairs reports to the EMT room, and the Regional Field Public Affairs officer accompanies the Regional Director to the site. Using information supplied to the EMT during briefings by the technical support directors and with the assistance of technical people on the staff, the Public Affairs Director drafts press releases. These are reviewed by the EMT members and then released through the NRC Office of Public Affairs.

The offices of the Office of Public Affairs are currently in the Maryland National Bank Building in Bethesda. It is from here, rather than from the Operations Center, that information is disseminated. This is a hindrance to an effective public information process that the NRC is trying to solve by providing temporary quarters for public affairs personnel in training rooms in the East-West Towers Building.

At present, there is no suitable place for the media to congregate in Bethesda for press briefings. To alleviate this, the NRC plans to convert some rooms on the fifth floor of the East-West Towers Building to completely outfitted press rooms. Should a new, consolidated location be procured, facilities for press relations would be desirable.

Media at the site will be based in the near-site Emergency Operations Facility. This center, required of all licensees, will include facilities for briefing the press. It is expected that State, local, utility and NRC officials could all use this common location for briefings.

NRC personnel believe that journalists and reporters will seek information both from the site and from Bethesda and that NRC representatives at both locations will be obligated to answer media inquiries. (87) This raises the possibility of incongruous statements being made by representatives of the agency. To minimize conflicting statements, communication must be maintained and common information used in preparation of press releases. Press releases will be reviewed by both onsite and headquarters NRC personnel. In addition, at some point in the incident, the onsite public affairs person will be expected to become the "official NRC spokesperson." Nevertheless, a real possibility of conflicting press releases exists.

NRC personnel recognize that in some situations, such as occurred at TMI, apparently erroneous press releases may result from the rapidly changing situation. (88) This situation is now somewhat improved, with a member of the Commission on the EMT. This obviates the need for press releases to be reviewed downtown in Washington, D.C. Coordination of press releases with the site, however, will entail some delay. Press conferences, rather than press releases, could help minimize these delays. However, confusion during the first hours of the incident is unavoidable.

A further problem surfacing during TMI was the transmission of highly technical information in a form comprehensible to reporters. To assist in dispensing understandable information to the media, the NRC is embarking on several efforts. First, it is identifying articulate technical members of the staff to accompany public affairs officers on briefings of the media during an incident. In addition, a pilot program to inform media of how nuclear plants work and facts regarding radiation is being developed. This program, conducted by regional Inspection and Enforcement personnel, not only would inform the local media, but also would assist NRC personnel in understanding how to communicate comprehensibly with media personnel. A final benefit of the program will be the production of basic briefing materials, which could be used in press conferences during an incident.

DRILLS AND TRAINING

The Office of Inspection and Enforcement has been attempting to run drills for the Operations Center about once a month. The objectives of these post-TMI drills have been to familiarize participants with the revised incident response organization and equipment, to evaluate the post-TMI revisions to the plans and to test initial notification and assembly. According to Bernard H. Weiss of the Office of Inspection and Enforcement,

> New procedures and ideas are being incorporated into each exercise to assist in the development of the most effective means of responding to incidents. (89)

There have actually been only three drills in the year since the accident at TMI. One planned for March 4, 1980 was cancelled due to the Crystal River activation on February 26. Weiss stated that "we [I&E] will hopefully go back on a schedule shortly of drills about once a month." (90) A drill involving a safeguards incident was conducted on May 19, 1980, and a Special Investigation staff member observed the exercise.

A MITRE Corporation evaluation of a December 1979 drill pointed out that participants in the exercise were not clear what their functions were, as there had been no pre-exercise briefing to explain the newly-promulgated procedures. (91) E. Morris Howard, who has overall responsibility for upgrading the Incident Response Program, did not view this as a criticism of his division's pre-exercise planning:

> I would hardly think it is necessary for people of that level to have procedures explained to them . . . We found out they were not reading [their response procedures] . . . It was embarrassing to them, and then, they did read them between that one [the December 1979 drill] and the next one [January 1980]. (92)

Although the May 19 drill involved a safeguards incident rather than a reactor incident, several relevant observations can be drawn. Those who had participated in earlier drills seemed to respond best, particularly Inspection and Enforcement personnel. Moreover, the EMT has begun to function effectively in its deliberations, requests for information and orders to support staff. (93)

However, the Operations Center response organization continues to suffer from recurring problems with internal communications. While some of the observed problems can be ascribed to the newness of the Office of Nuclear Materials Safety and Safeguards personnel to this type of exercise, some are endemic to the response procedures, organization and physical layout of the Center. (94) For example:

- The communications room is in close proximity to the EMT room, and during the exercise, the lead technical support director was working in the communications room. As as result, much of the incoming information was sent from the external communicator in the communications room through the technical support director directly to the EMT, bypassing the several technical support teams in outlying offices.
- The intercoms between the communications room and the satellite offices each picked up two or three extraneous conversations. At least one technical support team found this to be more distracting than helpful and turned off its intercom entirely.
- The electronic status boards lost much of their appeal as they were not always kept up-to-date. Furthermore, their outputs often created confusion due to difficulties in erasing old messages. Some critical information known in the communications room never got on the status boards. When several significant items that had not been announced in the EMT room finally appeared on the boards, they went unnoticed by EMT members for a long period of time.

An earlier MITRE study (95) and the NRC Draft Action Plan (96) recommended that the NRC should develop a schedule of drills to include all key participating parties. However, those trying to upgrade the NRC emergency response first want to ensure that the communicators, technical support teams and key decisionmakers understand what they are expected to do and that the revised procedures are working optimally. Bernard Weiss even expressed some reluctance about always involving the "senior management" in the drills:

> There has been extremely high interest, both by senior management and by the Commission. Therefore, they have been really wanting to come here. So we don't want to discourage it, but sometimes it is easier to go through an evaluation procedure without the senior management being here. (97)

In fact, Weiss feels notifications are not of primary importance at this stage, suggesting that an emphasis on assembling personnel may detract from an emphasis on the procedures once everyone is assembled. (98)

Nevertheless, Weiss indicated that the NRC plans to expand the scope of the exercises to include joint exercises with licensees, State and local agencies, and other Federal response organizations when they are more confident about their own internal Operations Center procedures:

> Once we start understanding and feel [ing] a little more comfortable in the kind of situation we have here and we work through those [Operations Center] procedures, [we will] keep expanding out to include each region, other Federal agencies . . . The problem is that if we jump in and do one big drill, you tend to get lost and can't focus in on the things that you really do. You just end up with a bunch of impressions. (99)

Federal Emergency Management Agency personnel did activate their response center during the May 19 drill involving a safeguards incident and "played along" for the duration.

The Office of Inspection and Enforcement is also attempting to make the exercises more realistic. In fact, the January drill was carried out using the simulator at TVA's Sequoyah plant in Tennessee. This proved to be more helpful than merely trying to make up an accident scenario.

The most recent activation of the NRC Operations Center occurred on February 26, 1980 in response to the incident at the Crystal River plant north of Tampa, Florida. At about 2:20 p.m., a short circuit caused an electrical failure that disabled a large number of the control room instruments, resulting in a reactor trip.

The NRC duty officer was notified over the dedicated phone line. An initial report of a pressure buildup in the containment building (18 psi "absolute" was erroneously thought to be 18 psi "gauge"),[15] coupled with 50 Roentgen on the containment dome monitor, resulted in Stello's decision to activate the Operations Center around 3 p.m. (100) It remained open throughout the night.

The Office of Inspection and Enforcement has not conducted and does not contemplate doing a formal evaluation of the workings of the Operations Center during the Crystal River incident. Nevertheless, E. Morris Howard's general impression is that the Crystal River activation was calm and that personnel more clearly understood their roles and functions. (101)

After Crystal River, Darrell G. Eisenhut of the Office of Nuclear Reactor Regulation elicited comments from the members of the Operations Evaluation team which he directed during the incident. (102) (Of the four technical support teams, this one is expected to concentrate on the long-range aspects of the reactor's operation.) The comments of these team members were much less sanguine than those of Inspection and Enforcement personnel. Some problems which were highlighted—such as cramped working space and too much noise for communicators—are known to Inspection and Enforcement, and it is searching for remedies as quickly as possible. Other criticisms included charges that there were too many people at the Operations Center, that the communications with the region and onsite personnel were inadequate and that the reference materials such as electrical drawings, piping and instrumentation drawings, updated Safety Analysis Reports, and Technical Specifications were in short supply. (103) As to the functioning of the technical support groups, several Operations team members said they need more meetings to work on training and coordinating the participants of the group. Most persons also thought the current division between short-term (status) and long-term (evaluation) is unworkable. To avoid redundant data acquisition and dissemination, they recommended that the two groups be combined into one team.

One of the more troubling of the comments was:

> I could see little improvement over the [Operations Center] response to Three Mile Island. The atmosphere was somewhat less chaotic, but only because fewer people were involved and no releases occurred. Clearly, the [Operations Center] formal organization chart collapsed, and an informal organization replaced it. (104)

LONG-RANGE PLANS: THE NUCLEAR DATA LINK

To improve information flow to the Operations Center, the NRC is currently studying the possibility of direct transmission of data from each site to the Operations Center. This concept, known as the Nuclear Data Link (NDL), is being studied by Sandia National Laboratories under a contract administered by the Office of Nuclear Regulatory Research.

The NDL is intended to provide the Operations Center with large volumes of prompt, accurate information on the status of the reactor, on quantities of radioactivity released and onsite weather conditions. In event of an accident, this information would allow the NRC to assess independently the seriousness of the event and the potential consequences to public health and safety.

Such a system, NRC personnel believe, would help solve several limitations inherent in the current telephone data transmission system. Data would be available in near real-time—that is, without significant delay—and would not be subject to the inaccuracies inherent in word-of-mouth communications in time of stress. (105) Large amounts of data would be available to NRC personnel that would, under current circumstances, overwhelm a phone link system. (106) Within the Operations Center, data would be simultaneously available to several groups of analysts without depending upon a communicator.

The system is viewed as particularly important to improving the agency's assessment of the accident in the first 3 to 6 hours before the NRC team can reach the site. For example, a Nuclear Data Link between the Crystal River plant and the Bethesda Operations Center would have eliminated the confusion over containment pressure during the first hours of that incident.

Although much more data would be available to the agency, NRC personnel hasten to point out that limitations to decisionmaking will still remain. Much more data will be available onsite for making decisions, and even the NDL is not expected to provide sufficient information to allow operational decisions to be made from Bethesda. (107) The NDL would, however, enhance the agency's ability to monitor and evaluate the situation and to offer advice or to make decisions such as those pertaining to recommending protective action.

DESCRIPTION OF THE SYSTEM

The Office of Inspection and Enforcement and the Office of Nuclear Reactor Regulation have provided the Office of Nuclear Regulatory Research, which is monitoring the contract with Sandia, a list of data that they want provided to the Operations Center through the Nuclear Data Link. The list contains around 100 parameters, about 60 of them operational and about 40 radiological and meteorological. These data, while not all that would be needed for every conceivable incident, would be expected to provide much of the necessary information for most incidents for both current status monitoring and longer-term accident evaluation. The combination of operational, radiological and meteorological data would assist in making decisions regarding the need for recommending protective actions.

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[15] 18 psi "absolute" is equivalent to 4 psi "gauge." An 18 psi "gauge" pressure would indicate a severe problem, whereas 18 psi "absolute" is less cause for concern.

As part of its conceptual design study of an NDL system for the NRC, Sandia National Laboratories personnel visited five utilities to ascertain the availability of these data for NDL purposes. (108) Nearly all operating reactors are equipped with a computer that collects data and processes them to provide information to the operators. Most of the data desired for the Nuclear Data Link are of the type fed into this "process computer" and stored in its memory. Prior to the site visits, therefore, many assumed that it would be a relatively simple matter to tie into each reactor's process computer to obtain data for the NDL.

The Sandia visits revealed, however, that "existing licensee process computers do not facilitate implementation of the NDL." (109) Most of the existing process computers are being used to capacity. Others are so unsophisticated they would require extensive and costly modifications and still might not meet the standards desired for the NDL. (110) In addition, during an unpredictable accident condition, their capabilities may be overwhelmed.

To circumvent these problems, the current design calls for the addition of a "Stand-Alone" mini-computer dedicated to the NDL system, that is, a separate, independent computer only for the Nuclear Data Link. Such a system would permit access to plant data directly from inputs to the process computer and would not interfere with the normal operations of the process computer. Thus, up-to-date information would be instantaneously available to the NDL even though the process computer may fall behind in processing information during an accident.

For those few plants lacking a process computer, data would be obtained directly from the sensors in the control room or from the instruments themselves.

Data collected at the site would be readied for transmission by the mini-computer or a special unit called a "smart-modem." Data would be processed to meet the form and content standards set by the telephone company for telephone line transmission. Similar signals would be generated for each reactor. Data would be sent at least once every minute over a dedicated telephone line from each reactor to the Operations Center in Bethesda.

Other means of transmission have been studied. Given the time constraints and the desire to use existing, commercially available technology, only telephone and satellite transmission appears feasible. Telephone transmission is preferred due to its significant cost advantages. It is expected that, should satellite transmission become cheaper, the system could be modified to transmit data by this means. (111)

Data could also be transmitted to other interested parties—such as reactor-vendors and architect-engineers or even State agencies—merely by providing other telephone lines, is at the discretion of the licensees. With this type of information, the vendor and architect-engineer could provide valuable assistance to the licensee. Given the proper expertise, State officials could independently assess the need for protective action. Both utilities and vendors appear to have expressed interest in this capability. (112)

Data would be continuously transmitted from each reactor whenever in operation to the Operations Center's central processing computer. This computer would store information from each reactor for 30 minutes. Certain parameters would be monitored by the computer to ascertain if off-normal conditions existed. Upon sensing significant abnormalities—such as a safety injection or containment isolation signal, a rapid change in neutron flux or containment pressures or actuation of pressurizer safety valves—an alert signal would be sounded in the center. Data for the 30 minutes prior to the event would be retained for that plant, and all subsequent data for the next two weeks would be stored. The duty officer, upon receiving the alert, would call up a display of data from the plant and telephone the control room over the hotline. From the information, a decision would be reached whether to activate the Center.

Upon assembling at the Operations Center, the NRC response team would be able to call up from the computer whatever data it wished (from the list of 100 parameters). It would also have access to the data from 30 minutes prior to the event to aid in reconstructing the sequence of events. With storage of data in the computer, analysts could request graphic displays to show trends. The capability to generate copies of such displays would be available. All rooms of the center would have cathode-ray tube displays showing the status of desired plant parameters.

OPERATIONS CENTER FACILITIES

Current physical facilities of the Operations Center may or may not be adequate. To implement the NDL, a central processing computer would be needed, perhaps a second one to provide added reliability to the system. Seven terminals for accessing data and over 30 cathode-ray tubes for data display are currently envisioned. E. Morris Howard believes that the current location could handle the increased space requirements. He believes that one could get by with about 5,000 square feet of space, although 10,000 square feet would be more reasonable. (113) Weiss, on the other hand, believes that space in the East-West Towers building is certainly inadequate and that 20,000–25,000 square feet would be necessary. (114) This view is supported by the Sandia study: "A new Operations Center must be made available because the NDL will not fit in the present East-West Towers facility." (115) In any event, any consideration of the question of NRC consolidation into a single location should take into account the need for an expanded Operations Center.

NDL INTERFACE WITH THE ONSITE TECHNICAL SUPPORT CENTER

The Office of Nuclear Reactor Regulation has required that, by January 1, 1981, all licensees have a fully operational Onsite Technical Support Center.[16] This Center would include access to an as yet-unspecified set of data to allow operational decisions to be reached away from the "hubbub" of the control room. How this requirement will mesh with the requirement, if promulgated, of having an operational Nuclear Data Link by January 1, 1982 (as currently envisioned) is not clear at this time. Nevertheless, "commonality, or interaction, with the Technical Support Center(s)" is an "issue having a significant bearing on the NDL design." (116)

There appears to be a lack of definition for the Technical Support Center. Although mandated, it has been defined functionally only in general terms. (117) The specific formal requirements prescribed by the NRC tend to deal with general design criteria rather than the functional purpose of the center. No detailed set of parameters has yet been promulgated. (118)

The NDL, on the other hand, is expected to place very specific demands on the licensee with regard to both the data required and the necessary transmission format. No decision, however, has been reached. In the words of Ormon E. Bassett, project manager for the NDL from the Office of Nuclear Regulatory Research:

> The nuclear data link is well-defined and has no status. The Technical Support Center, on the other hand, has complete status and almost no definition. (119)

Both the Technical Support Center and the NDL will require data. One set of data will probably be a subset of the other. To facilitate optimal implementation of these requirements on the part of the licensee, coordination of requirements would be desirable.

> While no resolution of the interaction between the NDL and the OTSCs [Onsite Technical Support Centers] has been reached, it is recognized that considerable benefit can be gained by considering the two concepts together. For example, similar displays at both locations [Operations Center and Technical Support Center] can serve to greatly enhance communication during emergencies. (120)

There appears to have been little coordination in this regard between the Offices of Inspection and Enforcement and Nuclear Reactor Regulation.

Licensees, however, have been made aware of potential conflicts. In a letter advising licensees of potential specifications for the NDL, Eisenhut, Office of Nuclear Reactor Regulation, stated:

> These actions [associated with the onsite technical support center] will interface with the NDL . . . It is apparent that close coordination is needed between the requirements being established for the NDL and those of the OTSC. . . . (121)

Until recently it appeared that by keeping licensees and the nuclear industry informed of the developments associated with the NDL, the NRC believed the problems would resolve themselves, rather than the NRC internally coordinating requirements to be placed on the licensee. A Commission briefing by NRC staff regarding the Nuclear Data Link on May 15, 1980, however, revealed recognition of this problem. (122) Nuclear Reactor Regulation personnel have been assigned specifically to coordinate these related concepts. On May 20, 1980, they met with representatives of the nuclear industry to discuss coordination of these efforts, and industry representatives presented an approach for integration of various safety parameter concepts under consideration by the NRC. (123) It remains to be seen how successful the NRC will be in integrating requirements involving the various concepts.

ACCESS TO DATA IN NON-ACCIDENT SITUATIONS

As stated above, data would be continuously supplied to the Operations Center whenever the plant is operating. This raises the possibility of NRC personnel obtaining data on plant operations in normal situations, rather than just when an incident occurs.

The nuclear industry appears to be somewhat concerned about this. Ormon Bassett states:

> We find that the industry in general is more concerned about having a link running all the time when they're in normal operation than they are about having it available when they're in an incident condition.
>
> We think this is the natural reaction of a licensee who thinks he knows what he's doing without having anybody to look over their shoulder. (124)

One utility representative is concerned that the NRC might tend to get involved every time something minor occurs at a plant, rather than leaving it to the operator to handle the situation. (125)

Representatives of the NRC, however, do not envision this as an improper role for the agency and, in fact, have apparently informed licensees that this is a possibility. (126) Given that the duty officer calls each plant once during each shift to check plant status and that Resident Inspectors are soon going to be in each plant, this use of the data link is not viewed by representatives of the

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[16] This is required of all licensees with operating reactors. For license applicants, the Technical Support Center must be implemented prior to licensing or January 1, 1981, whichever comes first.

NRC as an imposition. (127) One of the benefits of the system might be as an aid to training NRC employees in observing plant behavior during startup and shutdown situations. (128)

COST

Given the current specifications of the system, Sandia National Laboratories estimates that the installation of this system will cost the NRC about $22.9 million. (129) This cost would include installation of dedicated transmission lines from 80 reactors, equipment at the Operations Center and software development. The bulk of this money would be needed in fiscal year 1981, when most hardware would be procured, and in fiscal year 1982. (130)

The agency anticipates that the licensees would pay the costs of supplying data to meet the NRC's specifications. In most cases this would entail at least the purchase and installation of a dedicated mini-computer. Cost estimates are around $100,000 per reactor. (131) If data are not available from a process computer in the plant, the cost of obtaining data could increase substantially. Cost estimates of up to $15,000 for each data point (in the worst case) have been stated. (132)

In addition, a yearly operating and maintenance cost to the NRC of up to around $2 million is predicted. "A major contributor in this category is the manpower required for system testing and troubleshooting." (133)

In a letter to Commissioner Victor Gilinsky, the Advisory Committee on Reactor Safeguards said "the proposed system is likely to be large, expensive to install and operate, and might take ten years to put into operation." (134) They suggest first installing a less elaborate system.

TIMETABLES AND OTHER ALTERNATIVES

Sandia has completed and published its initial concept study for the NDL. (135) It is expected that the system could accommodate changes in the NRC's needs with minimal problems. Further progress on this concept awaits approval of the concept by the Commission. To proceed, funds must be committed to allow procurement of the computer for the Operations Center.

In conjunction with the fiscal year 1980 authorization bill, the House-Senate Conference Committee required that:

> The Commission shall prepare and transmit to the Congress a study of alternative plans for instantaneous and otherwise timely transmission to the Commission of data indicating the status of principal system parameters at [licensed] utilization facilities. . . . (136)

On May 5, 1980, the House of Representatives Committee on Interior and Insular Affairs expressed some reservations regarding a Nuclear Data Link as proposed by Sandia. Its letter states:

> The Interior Committee intends that the Commission use the $300,000 to study alternative plans for instantaneous and otherwise timely transmission of data to the Commission. In this regard, we are concerned that the proposed funding is at such a level that the study may be weighted towards options where data would be transmitted to the NRC in such quantity, that the Commission itself might be tempted to become overly involved in operational decisions during the course of an accident. We believe any such involvement is potentially dangerous, and that any move in such a direction should be embarked upon only after the most careful thought is given the consequences of doing so. Accordingly, we believe the option of telecopy transmission of data should be as carefully considered as the other options. (137)

The Senate Subcommittee on Nuclear Regulation expressed its views of the study in a May 12, 1980 letter:

> The Subcommittee would like the study to include . . . a plan for remote and instantaneous monitoring of the principal system parameters at each nuclear power plant and for decisionmaking during an emergency based upon the information from such monitoring. (138)

On May 15, 1980, the Commissioners were presented with the Sandia-proposed concept along with three less costly alternatives. These other concepts would involve tying in to a licensee-supplied mini-computer to be used for supplying data to the onsite Technical Support Center.

These other alternatives involve:

(1) Simply a line printer to spew out unprocessed data at the Operations Center (for $0.5 million);

(2) The above alternative augmented by a data processing capability at the Operations Center (for $8 million);

(3) A Sandia-like system only using the licensees' Technical Support Center computer to send data to the Operations Center (for $11.6 million).

These costs exclude annual operating and maintenance costs—about $1 million or so for each alternative. (139)

Industry costs may vary greatly depending upon the alternative chosen. According to information presented to the Commission—

> These costs to industry have been estimated to be as high as $150 million for the current operating reactors. (140)

Alternative 3 would appear superior to alternative 2, given the small cost differential. Alternative 1, while significantly less costly, would hamper the deliberations of the Operations Center personnel by not providing pre-event data and a capability to provide trends, and by the awkwardness of the display of information.

The alternatives are receiving further consideration by NRC staff. Delay in making a decision, however, will inevitably delay implementation past the January 1, 1982 target date of the Draft Action Plan. E. Morris Howard put it this way:

> [E]very day that it [the decision] isn't reached is a day longer getting it in. That has been made clear to them [the Commissioners] that every day, one for one, there is a delay at the other end. (141)

The Sandia NDL concept study concurred:

> The controlling item [in the critical path], from the NRC standpoint, is the procurement, installation and check out of the Operations Center equipment. As indicated, this process will be delayed on a day-for-day basis if NRC authorization is not obtained by May 16, 1980. (142)

A decision has not yet been made.

CONCLUSIONS AND RECOMMENDATIONS

IMPROVEMENTS

Several areas of improvement are apparent when one compares the NRC response capabilities that existed during the TMI incident with the changes NRC has made in that capacity since TMI.

1. Role of the Agency. The Commission, nearly 15 months after the Three Mile Island accident, provided the staff with a statement of the agency's role during an emergency. This role consists almost exclusively of monitoring plant status and licensee actions and offering any advice that NRC personnel might have. The agency, under unusual circumstances, may direct the licensee to perform certain actions or may even assume management control of the facility. This statement of roles provides guidance that was lacking during the Three Mile Island accident. It also recognizes the difficulty of performing any function beyond monitoring and advising the licensee without actually being at the plant.

2. Response Organization. If the NRC were to play a major monitoring and advisory role during an incident at a nuclear powerplant, the NRC organizational structure that existed at TMI needed to be changed. Accordingly, the Chairman or his designee now serves as head of the EMT during an accident. He is clearly in charge, and the agency should respond more decisively than it did during TMI. Although the remaining EMT members are identical, their briefings are provided more systematically through the efforts of an EMT Coordinator—a newly created position filled by a senior agency official.

The old IRACT has been abolished and replaced with four Technical Support Directors and Technical Support Teams whose respective functions have been more clearly defined. While the technical support teams generally follow organizational lines and functions (e.g., Office of Inspection and Enforcement staff are mostly on the short-term status teams, while Office of Nuclear Reactor Regulation individuals dominate the long-term evaluation teams), there are enough persons from outside the dominant organization represented on each team to provide heterogeneity of knowledge and experience.

Much more thought has been given to the role of the regional teams. The importance of having responsible NRC personnel onsite quickly following an emergency is better appreciated. Each plant will soon have a Resident Inspector with well-defined duties during an accident. The composition of the regional response teams has been better thought out to capitalize on the familiarity of regional inspectors with the particular plant. Such a team under the direction of the Regional Director is dispatched upon notification of the activation of the Operations Center. Plans call for turning over the authority of the agency to the Regional Director when he is ready to assume command onsite.

3. Protective Action Decisions. While the responsibility for recommending protective action to State officials lies primarily with the licensee, the NRC may also make such recommendations if it deems them advisable. The NRC has more clearly defined its role in this regard than it had prior to TMI. NRC personnel are much more cognizant of the role played by plant conditions in such a decision.

Guidelines have been provided to the licensees and the States that define classes or levels of emergencies and suggest actions that the licensee and the State should take given various plant conditions. These guidelines represent substantial progress in the consideration of plant conditions in making protective action decisions.

4. Equipment and Facilities. In spite of constraints involving budget and physical facilities, the NRC's Office of Inspection and Enforcement has upgraded the Operations Center in Bethesda. Some of the communications problems which occurred during TMI should not recur in future incidents. The NRC now has dedicated reactor operations phone lines to each facility, with extensions in each control room and other places at each plant. A second phone system dedicated to transmission of radiological information should soon be operational. Additionally, the ease of setting up conference calls with many more offsite parties from the Operations Center switchboard is being improved.

Communications inside the Operations Center have been improved, with a Commissioner on the EMT and the technical support directors talking directly to the EMT. The confusion of so many people in a single noisy room with the communicator has been somewhat alleviated by removing them to separate satellite offices. The operations room becomes a communications room in both name and function. The advent of electronic status boards permits instantaneous sharing of plant information among the teams which are dispersed into the several perimeter offices.

5. *Site-Related Centers.* The onsite Technical Support Centers and Emergency Operations Facilities required of all licensees will represent significant improvements. The Technical Support Center provides a facility detached from, but in relatively close proximity to, the control room. Here, utility and NRC operations engineers can work away from the noise and congestion of the control room. The Emergency Operations Facility will provide a centralized location for disseminating information to the media and local and State agencies.

6. *Notification.* NRC's Operations Center is manned 24 hours a day by duty officers. Although they received very limited training for the particulars of the job, most are highly qualified individuals selected to serve a single 8-hour shift for one or two weeks each year. Licensees are required to notify the duty officer over the dedicated phone line if any of several incidents occur at the plant. Previously, the licensee would notify the Regional Office, and headquarters would only be notified of severe incidents and would receive its information from the Regional Office rather than directly from the licensee. The duty officers are provided with an initial notification form and rather detailed procedures for whom to call during office and non-office hours.

7. *Responsibilities and Drills.* The post-TMI incident response organization has more clearly prescribed "call lists" for various contingencies. These should help ensure that each listed person will have the appropriate expertise and sufficient participation in training and drills to perform his assigned function during an emergency. Practice drills have improved the functioning of the organization. The EMT is performing more as a unit, and Operations Center personnel are gaining experience with their positions and more familiarity with Operations Center equipment.

8. *Media Information.* The NRC Office of Public Affairs is improving its planning for its response to future incidents. Improvements include upgrading of the regional public affairs offices, including training sessions with media representatives, the preparation of graphics for handouts and camera displays, procedures for approving and distributing press releases, and greater coordination between the site and headquarters spokesmen. Personnel within the agency capable of translating technical information into terms understandable to the media are being identified. All of these efforts should help reduce the unnecessary confusion created by misleading, contradictory or highly technical press releases.

9. *Nuclear Data Link.* The NRC is exploring the possibility of a Nuclear Data Link—a system for automatically receiving data in the Operations Center from the plant during an emergency. If the Commissioners decide to go forward with this project, it will improve the transmission of vital plant parameters and radiological and meteorological information to NRC headquarters. If implemented as conceptualized, it should also alleviate many of the NRC's internal communications problems. It may also be a less expensive way to provide a control room "presence" than the manpower-intensive proposal of the NRC's having a 24-hour representative in each control room.

Even if the decision is made not to go forward with the data link, the list of 100 parameters that has grown out of the study has helped create a focus for information needs at the Operations Center from the site.

CONCERNS AND RECOMMENDATIONS

1. *Role of the Agency.* Although guidance has been provided to the staff regarding their role during an emergency, this guidance has been quite general. The NRC may, under unusual circumstances, direct the licensee to take particular actions or assume management control of the facility. There is, however, little guidance as to what constitutes unusual circumstances. The only criterion is to take action if the licensee is not taking appropriate actions to protect public health and safety.

While circumstances will vary from accident to accident, making specific guidelines impractical, representative situations could be developed to provide insight into conditions in which direction or management control by the NRC would be appropriate.

Such a representative situation might be as follows. Assume an accident has occurred in which significant quantities of coolant have been lost. The licensee believes the core is covered and hence is injecting minimal coolant. Despite direct conversations with the licensee, a technical support director is convinced the core is not covered and believes more coolant should be injected. Under these circumstances, the question arises as to whether the EMT should issue a directive to the licensee to increase coolant flow.

Recommendation: The Commission should provide further guidance to the NRC staff regarding circumstances under which the agency would direct licensee action or assume management control of a facility under emergency conditions. Such guidance should include representative situations, in addition to general policy guidance.

2. *Delegation of Authority to the Site.* The difficulty of dealing with an accident without being onsite was clearly recognized by all involved in responding to TMI. The agency has recognized the importance of sending a team to the site and has delegated authority to the Regional Directors to act for the agency during an emergency.

As yet, however, procedures contain no specific guidelines for turning over responsibility for response from the Operations Center to the onsite team. Rather, it is a decision made by the EMT when it is confident that the Regional Director is fully informed and capable of dealing with the situation. This leaves open the possibility that during an ongoing emergency the NRC's decision-making authority may remain at headquarters if the Regional Director does not feel confident to deal with the situation until more experienced personnel from headquarters can arrive onsite. This could significantly delay the NRC's making decisions from onsite, where decisions are best made.

Given that the Regional Directors were not chosen with the role of directing the NRC's emergency response in mind, this policy may be advisable. However, the agency should develop sufficient capability in each region that authority may be transferred to the site *in every instance* when the regional team arrives and becomes informed of the situation.

Recommendation: The importance of making decisions onsite rather than at headquarters should be a recognized part of NRC emergency response procedures. The capability should be developed in each region so that the regional response team is capable of assuming authority—and so that headquarters is confident of relinquishing authority to the onsite team in every situation—after the team is fully informed. The capability of assuming command of the NRC's response in an emergency should be among the criteria for selecting Regional Directors.

3. Protective Action Decisionmaking. Although the licensee is primarily responsible for recommending to the State and/or local officials that protective actions be taken, the NRC also recognizes this as part of its role. The Federal Emergency Management Agency may also play a role in making such recommendations.

With so many parties involved, the possibility exists for conflicting recommendations and for confusion on the part of State or local officials who must make protective action decisions. There must be no confusion in making such an important decision.

Recommendation: The process for recommending to the State and/or local officials the need for taking protective measures should be clearly established. During the early moments of an accident, such responsibility should lie with the licensee. While it may be advisable for the NRC and other agencies to become involved in such decisions as events develop, State officials should not receive independent, possibly conflicting, information. Either any disagreement between the parties involved should be resolved prior to discussions with the State, or preferably all parties, including the State officials responsible for making such decisions, should discuss the situation in a conference call. Spokesmen for the utility, the NRC and other agencies should be designated in emergency response plans and should be made known to State officials to avoid confusion during an emergency.

In addition, although the role of plant conditions in making protective action decisions is recognized, explicit guidelines have not been published by the Environmental Protection Agency. Interim guidelines for determining emergency action levels, however, have been provided to licensees and State officials by the NRC and FEMA. These could form the basis for inclusion of plant conditions in protective action decisions, although they do not specifically address uncertainty concerning the status of the plant as a plant condition.

Recommendation: More explicit guidelines for incorporation of plant conditions into protective action decisions should be included in the Environmental Protection Agency's Protective Action Guides. While rigid guidelines may not be practical or desirable, guidance such as that published by the NRC and FEMA could form a basis in this regard.[17] Utilities, State officials, the NRC and others involved in making such decisions should have this document on hand until more definitive guidelines are published.

In addition, the NRC should assess the behavior of critical plant parameters in various accident scenarios to provide a basis for comparison of plant parameters during an unfolding incident. This information should be given to the Executive Management Team to provide further guidance in making protective action decisions based on plant conditions.

4. Space Requirements. The Office of Inspection and Enforcement has made significant improvements in the Operations Center since TMI. However, there are still no adequate press facilities, the communications room reverberates with noise when only a few people are talking, and the satellite offices are not large enough to house their teams during an incident. Other support staff are currently scattered among a half dozen buildings, often causing transportation or communications difficulties. If the Nuclear Data Link is approved, the current facility at the East-West Towers will not be able to accommodate the space requirements of the projected system. Hence, adequate space for effective emergency response remains a problem.

Recommendation: Expanded facilities for the Operations Center should be obtained. If a new, consolidated NRC location is to be sought, the requirements of a fully equipped Operations Center should be taken into consideration.

5. Communications with the Site. While the installation of dedicated phone lines will certainly aid in obtaining data from the plant, without some structured approach to communications, vital information may not be available in a timely fashion, may be inaccurate or may be lost. Although the Operations Center duty officer has an initial notification form to take down information, the licensee has not been given copies of the form to know ahead of time what information will be sought. Neither party has a list of parameters to be relayed during an emergency—this is to be developed as the incident unfolds. Communications with the site could be improved by ensuring both communicators have lists of data sought.

Recommendation: All licensees should be provided with copies of the NRC's "significant event report," the form used by the Operations Center duty officer upon notification of the incident. Further, both the licensee and the NRC communicator should have a well-defined list of data to be transmitted from the site to the Operations Center periodically during an emergency. If it is impractical to have one all-purpose list, an all-inclusive list should be developed. This list of parameters developed for the Nuclear Data Link could serve as such a list. Given this, both parties could agree upon the parameters to be transmitted (e.g., parameters number 1, 5, 7, 10, etc.). Many copies of the list should be readily available by the telephone so that data could be written on the form as received.

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[17] "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants," NRC, NUREG-0654, FEMA-REP-1, January 1980, Appendix 1.

6. Internal NRC Communications. While improvements have been made in this regard, the current system of transmitting information and requests between the technical support teams and the communicator represents the greatest potential for loss of information at the NRC during an emergency. A similar system broke down during TMI, and the existing system was circumvented during the drill witnessed by Special Investigation staff.

Recommendation: The possibility of providing some graphic communications such as the electronic blackboard between the satellite offices and the communicator should be explored. The implementation of the Nuclear Data Link, discussed below, would largely alleviate this problem.

7. Drills and Actuations. Successful response during the stress of an emergency depends upon all personnel being thoroughly acquainted with their functions and the workings of the Emergency Operations Center. This can only be accomplished through frequent drills and through experience with actual emergencies.

Since the Three Mile Island accident, drills have been infrequent and have included only headquarters personnel. However, there are plans to broaden the scope of the drills to include others once headquarters operations are well-drilled.

In the case of the Crystal River accident, the Office of Inspection and Enforcement did not seek evaluation of the emergency response operation from participants. Problems with the Operations Center not encountered in a drill situation almost certainly arose during the accident. Furthermore, actuations of the Operations Center are so infrequent that it is probable that many of the problems of coping with an ongoing accident are unrecognized and are not being addressed in the planning and drills of the Operations Center.

Recommendation: Drills of the Operations Center should be conducted more frequently so that all participants become thoroughly familiar with its operation. As soon as practicable, the scope of drills should be expanded to include Regional Office personnel, other Federal agencies, State and/or local officials and licensees.

Serious consideration should be given to more frequent actuation of the Operations Center to improve NRC's response under real-time emergency conditions. Evaluations of the Center's performance should be elicited from all participants following each actuation.

8. Using Conferencing Capability. The Operation Center telephone systems have been upgraded to the point that conference calls are relatively easy to set up. However, the uses to which this capability could be put during an incident prior to the NRC's making major decisions do not seem to be appreciated.

The reactor-vendor and the architect-engineer represent great sources of knowledge about the plant and its behavior. Discussions with such personnel, in conference with the licensee, would provide valuable insight before issuing operations-oriented directives. This would be particularly true if the NRC, the vendor and the architect-engineer were all receiving data over a data link, as discussed below. Further, discussions regarding protective actions may usefully include knowledgeable State officials in conference with the NRC and the licensee.

Recommendation: The establishment of multiparty communications involving the licensee, the NRC, the reactor-vendor, the architect-engineer and the State should be a well-practiced operation. The potential contributions of such personnel and the desirability of holding such discussions, particularly prior to making operational decisions, should be part of the NRC's standard emergency response procedures.

9. Informing the Media. The Public Affairs Office plans in future emergencies to continue having at least two official media voices—one onsite and a second in Bethesda. Such a plan could lead to confusion and the release of contradictory information, which serves neither the agency nor the public well.

Recommendation: All information released by the NRC should come from one source. During the first hours of an incident, this would logically be the Operations Center in Bethesda. Upon arrival of the onsite team and its becoming familiar with circumstances, information should logically be released from the site. Recognition of this should be reflected in NRC procedures, and guidelines for transferring the "voice of the agency" should be established.

10. The Nuclear Data Link. It is important that the NRC be well-informed during an emergency. The proposed Nuclear Data Link would solve many existing problems:

(*a*) Accurate, timely information would be available from the site independent of the licensee or dependence on phone conversations;

(*b*) Information would be simultaneously displayed to each of the support teams and the EMT, alleviating many of the NRC's internal communications difficulties; and

(*c*) More intelligent, timely and decisive decisions could be made given accurate information, the ability to analyze trends and the storage of pre-event data.

Nevertheless, the importance of making decisions onsite should be stressed, and installation of such a data link should not be used to expand the scope of the NRC's role in Bethesda beyond that for which the data link is being designed: monitoring and advising the licensee.

Reactor-vendors and architect-engineers, by virtue of their familiarity with the plant's design and operation, could provide valuable assistance to the licensee if they were also equipped with a data link. As discussed above, in calls with the NRC it is desirable for both parties to have the same data.

Recommendation: The Nuclear Data Link, in some form, is a desirable capability for the NRC's emergency response. The Commission is urged to clearly define the uses of the data link during both emergency and non-emergency situations and to move forward in developing a Nuclear Data Link to assist it in performing its role. The data link should include features as discussed above. Should a data link be installed, reactor-vendors and architect-engineers are encouraged also to be equipped to obtain the same data.

11. Coordination of Requirements. While the onsite Technical Support Center, the Nuclear Data Link and the Emergency Operations Facility all appear worthwhile (along with a safety panel concept not addressed in this study), the lack of definition and coordination of functional requirements for each of these raises the possibility of inefficient expenditures of manpower and resources for both the agency and the nuclear power industry. The NRC appears recently to have recognized this problem and is beginning to address it. This effort should be encouraged, and it is to be hoped a realistic, coordinated approach to these problems will be forthcoming.

Recommendation: Requirements for the various safety-related concepts—the onsite Technical Support Center, the Nuclear Data Link, the Emergency Operations Facility and the safety panel—should be coordinated to allow for efficient use of NRC and industry manpower and resources. Realistic timetables should be established to allow for the coordinated implementation of these concepts as soon as it is practicable.

A FINAL ANALYSIS

The NRC has made substantial progress in its emergency response capability since the Three Mile Island accident. However, significant problems still remain, particularly with regard to information flow from the site and within the Operations Center. Given these problems, if a serious accident were to occur tomorrow, the agency may still not be able to respond effectively. Much work remains to be done.

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Chapter 2

Backfitting at Nuclear Powerplants

By

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Chapter [illegible]

Back-Fitting at Nuclear Powerplants

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INTRODUCTION

The Nuclear Regulatory Commission requires continuous conformance to its regulations during the lifetime of each licensed facility, unless a specific exemption is granted. Non-conformance can result from two possible situations. One is through an advance in knowledge concerning reactor design and reactor safety. This process inevitably leads the NRC to identify new requirements to ensure adequate safety. Examples would be new methods of calculating safety system performance; new or revised procedures, training or qualifications for operators; and additional instrumentation, components or even entire systems. These requirements are in addition to those in force at the time existing facilities were licensed, and many licensed facilities might have to undertake modifications to their design or operation to accommodate the new requirement. The modification of a licensed plant to meet a new requirement is referred to as "backfitting."

The second way that non-conformance to NRC regulations can occur arises when there is some change in the physical state of the plant itself or in the understanding of plant design or operations. Examples would be the discovery of cracks in the reactor coolant system or an error in a design calculation for a safety-related system. If the cracks were a certain size, the integrity of the reactor coolant system might no longer be assured. If the error in analysis were significant, the safety system might not be able to perform its function. In either case, the plant would no longer be in a state equivalent to that which was the basis for the issuance of the Operating License. Such a situation precipitates a per se requirement to resolve the problem so that the plant is returned to its original, licensed condition. These types of actions are not considered backfitting.

THE BACKFITTING ISSUE

Often newly-identified items of the first category are of sufficient safety significance that all nuclear powerplants, old as well as new, will be required to adopt them. At other times, the new item represents only a better or marginally improved way of doing something; while it may be appropriate and justifiable to impose the change on new plants, there may be no compelling need for existing plants to make it.

This differentiation of new regulatory requirements into those that need to be applied to all plants and those that only need to be applied to new plants is the heart of the backfitting issue. It arises because of the dynamic nature of nuclear safety technology, the evolution of new regulatory requirements consistent with advances in technology, and the authority of the NRC to require that certain new regulations, though not a prerequisite at the time of licensing, be applied to existing license holders.

It is the question of whether new rules should be applied to existing plants that gives rise to the difficult and controversial nature of backfitting. On the one hand, it creates continuing uncertainty for license holders as to the body of regulatory requirements that must be met to maintain the license. This uncertainty translates into uncertain costs of operation and of the operability of nuclear powerplants. On the other hand, there must be some mechanism for retroactively applying new requirements if they are necessary to assure adequate safety.

Within this broad question the central issue is the methods and criteria by which decisions to require backfitting are made and the extent to which they balance the interests of licensees and their customers and the need to assure adequate public health and safety.

INTERPRETING THE BACKFITTING REGULATION

The statutory language of the Atomic Energy Act of 1954 does not specify the precise level of safety that the Commission must assure or the factors that may or should be considered in defining it. It simply states that applicants for Operating Licenses must provide such information as the Commission may deem necessary

> . . . to enable it to find that the utilization or production of special nuclear material will be in accord with the common defense and security and will provide adequate protection to the health and safety of the public. (1)

Adequate protection is not defined.

The legislative history of the Atomic Energy Act does not provide clarification as to what constitutes adequate protection or the factors that may or should be considered in determining adequate protection. In the report of the Joint Committee on Atomic Energy, facility licensing under Section 103 was described as "subject to regulation by the Commission in the interest of the common defense and security and in order to protect the health and safety of the public." The Commission was "required to issue licenses to all qualified applicants without other discretion on its part. . . ." (2)

The first formal appearance of backfitting in the regulations governing commercial nuclear power plants was on April 16, 1969, when the Atomic Energy Commission (AEC) published for comment a proposed new section to Part 50, Title 10 of the Code of Federal Regulations (10 CFR 50.109). (3) The purpose of the proposed regulation was to indicate the circumstances under which the AEC could require backfitting of facilities. On March 31, 1970, the AEC promulgated the regulation, essentially unchanged. (4)

The regulation, 10 CFR 50.109(a), "Backfitting," reads as follows:

> (a) The Commission may, in accordance with the procedures specified in this chapter, require the backfitting of a facility if it finds that such action will provide substantial, additional protection which is required for the public health and safety or the common defense and security. As used in this section, "backfitting" of a production or utilization facility means the addition, elimination or modification of structures, systems or components of the facility after the construction permit has been issued.

Several points should be noted. First, the statute is authorizational, not directional. That is, it notifies the licensee that the Commission has the authority to require backfitting.

Second, backfitting may be required only if the Commission finds that the action will provide "substantial additional protection which is required for the public health and safety. . . ." Thus the broad authorization to require safety improvements is contingent on their substantially increasing the protection of the public.

The terms "substantial additional protection" and "required for safety" raise questions about the threshold requirements for a backfitting decision. The term "substantial" is not defined. It could be interpreted to mean anything that is meaningful or non-frivolous. This interpretation would raise a question as to why a backfitting action would have to provide significant additional protection if, as section 50.109 goes on to state, the action is "required for safety." It would appear that even an incrementally small protective action, if required for safety, should not also be subject to a test of being significantly large.

A third point about the regulation is that it does not specify the factors the Commission must or may consider in reaching a decision. At best, the language of the backfitting statute provides only general guidance, and one must look elsewhere for clarification.

At the time 10 CFR 50.109 was promulgated, (5) the AEC stated ". . . The rapid changes in technology in the field of atomic energy result in the continual development of new or improved features designed to improve the safety of production and utilization facilities." Section 50.109 which follows defines the circumstances under which the Commission may require backfitting of facilities. It is not entirely clear that this acknowledgement of the dynamic nature of nuclear safety technology suggests that safety standards should exist in a fluid framework, i.e., as enhanced safety levels become achievable, the NRC should require the changes necessary in existing plants to bring them up to the improved level of safety. Certainly the provision for a separate and distinct backfitting authority, apart from the NRC's inherent power to require continuing conformance to its regulations, envisioned the possibility that adequate public health and safety would be an evolutionary rather than a static process.

Judicial decisions to some extent have provided a concept of adequate protection that may, in appropriate circumstances, entail some balancing of safety against competing considerations. In *Nader* v. *Ray*, 363 F. Supp. (D.C. D.C. 1973), plaintiffs brought suit to challenge the validity of interim acceptance criteria for Emergency Core Cooling Systems required of light water cooled nuclear power reactors and attempted to enjoin the AEC from permitting continued operation of some of them. One of the issues was whether the AEC had violated its legal duty to assure safety in its licensing process.

The court held that the AEC had not violated its duty. The court stated that the "reasonable assurance" standard of safety, upheld by the Supreme Court in *Power Reactor Development Co.*, v. *International Union of Electric, Radio, and Machine Workers, AFL–CIO*, does not mean absolute safety, but is subject to changes as the state of nuclear safety advances. The court endorsed the discretionary balancing process used by the Commission to carry out its statutory mandate to assure adequate protection:

> It is for the Commission to weigh the state of that art, the risk of accidents, the record of past safety performance, the need for further improvement in nuclear safety matters, and other considerations. Balancing these factors calls for the exercise of discretion by the expert agency in a judgmental process that is very different from the kind of "clear, nondiscretionary legal duty" to comply with the procedural requirements of the National Environmental Policy Act. . . . (6)

However, the language "need for further improvement in nuclear safety" is ambiguous. One interpretation would be the need to improve the level of safety, that is, to reduce risk by providing additional protection. This would reflect the backfitting regulation 10 CFR 50.109. An alternative interpretation would be the need for improvements to maintain a minimum adequate level of safety, i.e. constant risk. In addition, the broad language of "and other considerations" suggests consideration of economic issues such as the cost of a proposed improvement, although neither the Atomic Energy Act of 1954, as amended, nor the Commission's regulations in implementation of the Act expressly cite cost as a factor to be considered.

NRC adjudicatory decisions also have addressed the issue of the safety standard. In *Maine Yankee Atomic Power Company*, 6 AEC 1003 (1973), (7) the Atomic Safety and Licensing Appeal Board held that adequate protection under the Act is measured solely by the nature and extent of the risk and that the amount of the benefits associated with plant operations can play no role in safety decisions under the Act. While the decision does not address the role of the cost of a safety improvement, a reasonable inference from the decision is that cost would be irrelevant in determining adequate protection. The NRC does, however, take into account analyses of the need for power (conducted by the Department of Energy) in timing plant shutdowns to effectuate safety modifications.

COSTS AND BENEFITS OF BACKFITTING

The "backfit rule" and threshold safety criteria came under scrutiny when one NRC and three General Electric engineers resigned and raised several serious reactor safety questions. In an ensuing Congressional investigation in 1975, the director of the NRC's Office of Nuclear Reactor Regulation articulated the role of costs and benefits in reactor safety reviews and backfitting as follows:

> In determining whether a safety issue warrants backfitting to older plants, a judgment is made first of the *safety significance*. This judgment is based on technical considerations only, and is not influenced by political or economic factors.
>
> Once a position defining an acceptable level of safety is established by both quantitative and judgmental processes, backfitting action is initiated, as appropriate, to assure that at least that level of safety is achieved. Further safety improvements are then evaluated considering the value of the added safety as well as the economic or other impact of the requirement. (8) (Emphasis added.)

This formulation does not address how the minimum "acceptable level of safety" is established. It would appear, however, that even though compliance with that minimum standard is demonstrated, the Commission may require additional improvements as long as the increase in protection is worth the cost. This raises again the section 50.109 dilemma. Under what conditions may, or should, the Commission require improvements in safety beyond the minimum adequate level of protection? Must the improvements be cost-effective? Must they provide substantial additional protection? And if they constitute a safety increment beyond the minimum and equal to adequate protection, do they satisfy the "required for safety" caveat of section 50.109?

In summary, the Atomic Energy Act of 1954 and its amendments, its legislative history, the Commission's regulations, and judicial and adjudicatory decisions do not clarify the issue of adequate protection and the threshold criterion for backfitting. Does backfitting require that safety improvements paralleling advances in nuclear safety be applied retroactively to operating reactors as well as prospectively to Operating License applicants? If so, what are the factors the Commission should weigh in determining the need to backfit?

At the time of the TMI accident, both the safety goal for nuclear plants and the criterion for backfitting were ill-defined. They still were, more than one year after the accident.

BACKFITTING BEFORE THREE MILE ISLAND

While section 50.109 is the formal statement about backfitting in the Commission's regulations, for several reasons the NRC had invoked it rarely prior to TMI. First, licensee compliance seldom required formal orders from the NRC. Licensees usually acted upon notice from the NRC of an impending required action in order to avoid the procedural complications of public hearings that attach to NRC orders. Second, many new requirements were identified by operating plants during the periodic reviews for reloading of new fuel or during generic reviews of important safety issues.

In order to stabilize and document its licensing review requirements, later in 1975 the NRC published a Standard Review Plan, (9) a formal document which set forth internal review procedures and acceptance criteria to be followed by the NRC licensing staff in evaluating license applications for power reactors. The principal purpose of documenting the licensing requirements was to facilitate the identification of any new requirements that might arise in the context of specific reviews and to channel them to a central forum for scrutiny and control by management. Previously, without such controls, new requirements could be imposed in the licensing review of a particular reactor, often without significant participation by senior agency officials; the application of that requirement often served as a precedent for all subsequent reviews of other reactors.

In March 1974, shortly before issuance of the Standard Review Plan, the NRC chartered an inhouse Regulatory Requirements Review Committee (RRRC)

> . . . to review proposed changes in Regulatory requirements for nuclear powerplants that are referred to it, . . . and to review implementation schedules including, as appropriate, rosters of affected facilities. . . . (10)

The RRRC was composed of senior management representatives from the NRC's major program offices: Reactor Regulation, Research, Standards, and Inspection and Enforcement. The Committee's chairman was the deputy director of the Office of Nuclear Reactor Regulation. Decisions were reached by majority vote. The Committee convened as often as necessary to keep abreast of proposed new requirements, but generally it was about once a month.

The RRRC was to provide assurance that backfitting, both procedurally and substantially, was controlled, justified and streamlined. It was to afford a management review of all those generic items constituting significant changes from or additions to existing regulatory requirements and interpretations. Recommendations of the RRRC were forwarded to the director of Nuclear Reactor Regulation for final determination.

From March 5, 1974 to February 13, 1979, the Committee met a total of 82 times (11) to review changes in (1) Standard Review Plans, (2) Standard Formats for Safety Analysis and Environmental Reports and (3) Regulatory Guides used in the licensing reviews of powerplants which might entail new regulatory requirements or provide significant relief from existing requirements. The RRRC has not formally convened since February 1979 and the TMI accident.

The Committee's charter did not provide a standard for review or a decisionmaking criterion. It said only that:

> . . . [t]he Committee should review proposed backfit actions under 10 CFR 50.109 . . . Items lacking adequate justification should be disapproved and eliminated as they surface through the management review chain. . . . (12)

At about the same time, the use of impact/value assessments in evaluating proposed regulatory actions was initiated. An in-house memorandum from then-NRC Chairman William A. Anders, dated April 15, 1976, read:

> . . . I was told that nine out of nine recent RRRC actions were based on impact/value assessments . . . The assessments in these documents are a good start . . . The objective of this process should be to relate expert ideas and judgments through concrete expressions of public benefits and public costs. Only in this way can we assure the public that we are not only protecting their safety and the environment, but we are doing it without unnecessary or counterproductive requirements. (13)

Although Anders stated that RRRC decisions were "based" on impact/value assessments, the weight or role played by cost assessments in RRRC decisions was not at all clear. The Committee's charter referred to section 50.109, which does not address value/impact, and the RRRC generally did not indicate the bases or criteria for its decisions.

However, on July 11, 1975, during meeting No. 31, (14) the Committee did agree to characterize each new licensing requirement into one of the three following implementation or backfit categories:

Category 1: Forward fit only with no need for further staff consideration of application to older plants;

Category 2: Referred back to staff for further consideration of the need for backfitting on a case-by-case assessment; or,

Category 3: Backfitting required of all facilities.

Since that time, the Committee has considered some 115 proposed guides or their revisions. It classified approximately 70 items as Category 1—no backfitting; 28 as Category 2—further staff consideration required to determine the need for backfitting; and 17 as Category 3—clearly backfit.

Documentation of the RRRC meetings consists only of summaries of the decisions made and actions taken. The RRRC has given no reasons for its categorization of regulatory guides and has not articulated the bases for its decisions or the criteria or safety goals considered.

Some 25 percent of the decisions made by the Committee to date involved Category 2—that is, the cases were referred back to staff for further consideration on a case-by-case basis. Since the RRRC did not provide specific guidance or criteria to the staff, it is not clear how the case-by-case determinations were to be made. And despite Anders' statement about the use of impact/value assessments as a backfitting justification, the General Accounting Office (GAO), which reviewed 37 Power Reactor Regulatory Guides (and revisions), including value impact statements issued between June 1976 and August 1977, found that only eight included estimates of dollars or time needed to implement the new requirements. The rest stated that either (1) the requirements were already being practiced and the costs were insignificant, or (2) the costs were unknown. (15)

A review of the minutes of a number of RRRC meetings reveals that some of these Category 2 items delegated to staff discretion had a high safety significance—items such as containment isolation provisions for fluid systems, instrumentation to assess plant conditions during and following an accident, and information relevant to assuring that occupational radiation exposures at nuclear powerplants are as low as reasonably achievable. (16) Thus while the RRRC provided a procedural mechanism for backfitting decisionmaking, its failure to make final decisions or to provide clear guidance to the staff on a significant percentage of issues created a critical void in the overall process.

The process of backfit decisionmaking therefore was largely ad hoc, with little or no involvement by the Commission and less than satisfactory direction by the RRRC. While the concept of the RRRC was sound in that it offered broad programmatic representation and agency consensus for new requirements, it was not an answer to the fundamental shortcomings in safety policymaking.

There were no standards, goals or criteria for development of proposed new requirements; section 50.109 was rarely referenced or invoked. The Committee's decisions provided no guidance to the staff as to the rationale they should use in determining the need for backfitting and no criteria for implementation of the requirement on a case-by-case basis. Nor did the NRC have established procedures or schedules for implementing approved requirements.

BACKFITTING SINCE THREE MILE ISLAND

The accident at Three Mile Island surfaced an array of weaknesses in safety requirements for nuclear power plants. Immediately following the accident, the NRC acted, through the issuance of bulletins from the Office of Inspection and Enforcement and Commission orders, to effect remedial actions in the most urgent areas. These actions, being of an emergency nature, bypassed the normal backfitting channels.[1] Later, the Lessons Learned Task Force was organized within the NRC's Office of Nuclear Reactor Regulation. It was chartered "to identify and evaluate those safety concerns originating with the TMI–2 accident that require licensing actions for presently operating reactors. . . ." (17) Further, it was to recommend needed regulatory actions to assure the continued safe operation of licensed reactors.

As it developed, the normal backfitting procedures remained suspended and had not, as of June 1980, been reinstated. The RRRC last met, as noted, in February 1979.

The post-TMI lessons learned exercise has and is providing a useful exploration of the substantive criteria applied to backfitting, in addition to identifying needed changes in the procedures governing backfitting.

THE LESSONS LEARNED TASK FORCE

Actions recommended by the Lessons Learned Task Force were subject to approval by the Director of Nuclear Reactor Regulation and the Commission prior to implementation. In effect, the Task Force acted as a defacto RRRC in that it critically sifted through and examined possible new requirements from sources within and without the NRC, and it exercised its collective expertise in arriving at recommended actions. Proposed recommendations for short-term actions were decided one at a time by a two-thirds majority vote of the Task Force members. (18) Later the recommendations were informally discussed with the RRRC. Discussions were also held on two occasions with the TMI–2 Subcommittee of the Advisory Committee on Reactor Safeguards; others were held with the Commission. Ultimately the Task Force voted affirmatively on 23 recommendations.

SUBSTANTIVE CRITERIA

The Task Force recommended some items for action in the near term "if their implementation would provide substantial, additional protection required for the public health and safety." (19) This was a conscious attempt by the Task Force to apply the criterion provided in the language of section 50.109. More important perhaps than the criterion itself was the clear articulation of the basis for recommended actions, in contrast to many previous regulatory decisions, such as those made by the RRRC, where the required action was merely approved without further elaboration. In adopting the section 50.109 language as a basis, the Task Force made clear that for purposes of short-term upgrading, the action had to have significant safety impact and be required (i.e., essential) for adequate safety. This approach precluded value/impact balancing and the flexibility of case-by-case implementation.

This stringent basis for decisionmaking carried on through the approval of the recommendations by the director of the Office of Nuclear Reactor Regulation and the Commission. Eventually all short-term recommendations were implemented at all plants.

While the criterion employed by the Lessons Learned Task Force is not the only or necessarily the best formulation of a backfitting threshold, it does demonstrate the advantages of clearly spelling out the basis for remedial actions in that the result is the rapid and uniform implementation of those actions.

SAFETY GOAL

In its longer term deliberations, the Task Force also addressed the questions of safety policy and backfitting criteria. It observed that "The Commission has alluded to a more definitive safety policy by taking actions that in effect say, 'no more Three Mile Islands.'" (20) Furthermore,

> . . . the lack of a definitive statement of the safety objective or goal of this agency creates an ever-increasing residuum of uncertainty within the staff as to the safety objective itself, as well as to the level within the agency from which such policy should issue. (21)

While the exposition of a nuclear safety goal certainly transcends the issue of backfitting, the Task Force concluded that "[it] is at the core of the long-standing debate on how backfit decisions are to be made" (22) and that the "goal would be used by the staff . . . as a threshold for backfitting of these or current requirements to existing plants." (23)

In essence the Task Force was saying two things about backfitting:

- First, a substantive criterion needs to be established that will act as a trigger for applying new requirements to plants already licensed; and

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[1] Emergency actions are not peculiar to TMI and are not directly relevant to a discussion of the backfitting process.

- Second, such guidance needs to flow as a matter of policy from the highest level of the agency, the Commissioners.

The Advisory Committee on Reactor Safeguards endorsed the recommendation. The Commission's position, however, must be pieced together. Commissioner Hendrie stated:

> There has been criticism of this body of regulations and staff documents from the standpoint that it does not clearly define a quantitative safety goal or provide a clear statement of how much safety is enough. It is my view that it would be helpful to have a more precise definition of the meaning of adequate protection and how it is to be achieved. I believe that my fellow Commissioners share the view that an improved statement of the Commission's guiding safety philosophy and safety goals would be helpful. You would have to ask my colleagues themselves for a more detailed accounting of their views. (24)

In the Commission's latest draft of policy, planning and program guidance to the staff, it is promised that "the NRC will seek to define more clearly the level of protection of the public health and safety that it believes is adequate." (25) In a response for the record to written questions in connection with the NRC FY 1981 Authorization hearing of the Senate Subcommittee on Nuclear Regulation, the NRC stated that "There are organizational changes and policy development activities now underway within the staff to improve the clarity and technical basis for backfitting in general." (26)

When asked in March 1980 what specific activities were underway, the Commission pointed only to a research program on risk assessment methodology and an Advisory Committee study on quantitative safety criteria. (27) The TMI Action Plan—the digest of post-TMI actions—redelegates work on development of an NRC policy statement on safety to Section V of the document, but established no priorities, schedules or resources. (28) However, in early June the NRC did give the Office of Policy Evaluation overall responsibility for coordinating staff efforts on the formulation of safety goals, a move called for in the NRC Action Plan.

It may be too early to tell, but it does not appear that the Commission has embraced the spirit of the Task Force recommendation: "The Task Force feels that it cannot stress enough the importance of a safety goal in achieving a balanced regulatory perspective." (29)

LONG-TERM ACTIONS

As discussed above, the TMI Action Plan is a compendium of all proposed TMI-related activities. It organizes, consolidates and prioritizes the recommendations of The President's Commission on the Accident at Three Mile Island, the Nuclear Regulatory Commission Special Inquiry Group, the Lessons Learned Task Force and others.

While not directly a mechanism for making backfitting decisions, the Action Plan's prioritization illustrates the continuing uncertainty inherent in making judgments about new regulatory requirements. Initially, individual items in Draft I of the Action Plan were categorized according to their potential for improving safety (high, medium or low). This categorization was based on the collective judgment of a Steering Group composed of representatives of the major NRC offices. Later drafts of the Action Plan were developed under the guidance of an expanded Steering Group and incorporated a numerical scoring system to establish the relative priority of each task. This system assigned points for safety-significance (again based on a 3-tier system), resources necessary to accomplish the task, present status of tasks and timing or improvement. The dominant weighting factor was safety. In the words of the Action Plan, "[i]t was designed to give highest weight to the tasks with greatest potential for improved safety in the shortest time at lowest cost to industry and government." (30)

Two aspects of the approach taken in the Action Plan are noteworthy. First is the similarity of the Steering Group and the RRRC—both are broadly-based collegial bodies exercising subjective judgment on regulatory actions. Second (and unlike the RRRC's approach) is the apparent need to structure these judgments according to identified and weighted criteria. While these criteria are more specific than those used in the bald judgments rendered by the RRRC, they stop short of a threshold-type finding for safety. Only a gradation of actions is decided. Admittedly, the goal of the Steering Group was prioritization and not selection of regulatory actions, but what can be observed is the potential elevation of items of low safety significance because of factors such as cost and schedule.

In summary, actions may be required simply because they are relatively easy or inexpensive—not because they satisfy a compelling safety need. Conversely, items of fairly high safety significance may not receive the appropriate attention because they are expensive or time-consuming. This is analogous to pre-TMI backfitting, where the safety significance of potential new requirements could effectively be diluted by cost and resource considerations.

EVALUATION OF PROGRESS

The year since TMI has seen an unprecedented array of new regulatory requirements imposed on currently operating nuclear plants and a vast reservoir of potential new requirements to be studied. The resultant impact of these requirements will be large and hopefully will produce the desired effect on safety. However, the proliferation of new requirements creates both the need and opportunity to examine the institutional process of backfitting critically.

In the post-TMI period, the established mechanism for making decisions about new regulatory requirements has been supplanted by something that looks different, but which is much the same in practice. The approval process has been elevated, and new requirements now have the imprimatur of the Commission. The formalized RRRC review has yielded to multiple ad hoc consultations, but the review process still relies heavily on the collective judgment of senior agency officials.

Of most concern is the persistent lack of criteria and objectives to be applied to the process of establishing new regulatory requirements. Aside from the Short-Term Lessons Learned recommendations that embodied a basis of "required for safety" pursuant to section 50.109, scant reference has been made to the underlying rationale for these actions. To a certain degree the lack of criteria is natural in a period of intense reassessment of safety issues and the need for prompt decision-making. On the other hand, there appears to be no reform of what has become habitual reluctance to bring discipline and theoretical structure to the backfitting process.

At the core of rational and predictable backfitting should be a safety goal or objective for nuclear power regulation. Despite the strongest of recommendations by the Lessons Learned Task Force, and its endorsement by the Advisory Committee on Reactor Safeguards, the Commission has steadfastly resisted any genuine initiative in this regard. The goal, which would define the required level of safety for nuclear plants, should act as a threshold or trigger below which backfitting must be required and above which backfitting could not be required.

The institutional process that implements backfitting is probably of secondary importance. While the interpretation and application of a safety goal involve inherent subjectivities, it appears that reliance on the judgments of senior agency officials, whether they be cast as an RRRC, a Steering Group or the Commission itself, is a reliable mechanism. In fact, this mechanism should be materially enhanced by the commonality of purpose that a defined safety goal would bring to the deliberations of the individual members.

RECOMMENDATIONS

(1) The NRC should articulate a safety goal for the regulation of nuclear powerplants that incorporates a threshold test for backfitting of new or current requirements to existing plants. This is consistent with section 5 of S. 2358, the NRC FY 1980 Authorization Bill.

(2) Decisions to backfit new or current requirements should incorporate a date for completion of the required action.

(3) To the extent possible, backfit requirements should be applied to existing plants in a uniform manner. However, this should not preclude consideration of other methods of achieving the purpose of a remedial action or making appropriate adjustments so that any modifications are consistent with overall plant design.

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21. Ibid., p. 4-1.

22. Ibid., p. 4-2.

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24. Letter from Joseph H. Hendrie, Commissioner, NRC, to Senator Robert Stafford, Member, Senate Committee on Environment and Public Works, U.S. Congress, April 4, 1980.

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26. "Nuclear Regulatory Commission: Fiscal Year 1981 Authorizations," Hearing before the Subcommittee on Nuclear Regulation, Senate Committee on Environment and Public Works, 96th Congress, 2d Session, March 24, 1980, Question IV-3(c), p. 265.

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Chapter 3

Human Factors in Nuclear Powerplant Operations

Control Room Design
By
Robert F. Cudlin

Training and Licensing of Nuclear Power Reactor Operators
By
Robert L. Civiak, Congressional Research Service, Library of Congress

Procedures at Nuclear Powerplants
By
Vivien F. Lee

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HUMAN FACTORS IN NUCLEAR POWERPLANT OPERATIONS

The term "human factors" refers to the physical and psychological needs of people performing a certain task. A common theme in the many investigations since the accident at Three Mile Island has been the lack of attention to human factors in nuclear powerplant operations. Examples of human factors considerations are the ease with which equipment can be used under normal and emergency conditions, layout of control rooms to facilitate movement and response to crises, and presentation of information in a format and volume that plant operators can assimilate easily.

The three studies that follow each address a key aspect of nuclear powerplant operations in which human factors are of particular importance: control room design, operator training and licensing, and procedures governing plant operations. Three Mile Island revealed serious deficiencies in all three. The studies review these deficiencies and steps taken by the Nuclear Regulatory Commission to remedy them.

CONTROL ROOM DESIGN

INTRODUCTION

Prior to the TMI accident, control room design received only minimal attention by the NRC in its licensing of nuclear powerplants. As the Nuclear Regulatory Commission Special Inquiry Group observed, the NRC imposed

> . . . only the most general criteria on control room design and instrumentation, and thus there are virtually no human factors requirements for the design and layout of reactor control rooms, the readability or grouping of instruments, or what plant parameters and alarms must be displayed and how. (1)

The lack of clear regulatory criteria is of particular importance because control room design is not clearly or solely within the province of any single organization. Rather, it is the result of a joint effort between the vendor(s), architect-engineer and utility to arrive at a mutually satisfactory design that may or may not be optimum with respect to human factors or management of an accident. (2) The NRC is involved only minimally or not at all. The President's Commission on the Accident at Three Mile Island pointed out that the nuclear industry in the United States has been criticized in the past by human factors engineers for its lack of attention to control room design. (3) The Special Investigation of the Senate Subcommittee on Nuclear Regulation concurred with these criticisms.

Two facets of control room design need to be recognized and differentiated to understand current regulatory criteria. One is that the control room serves as the workplace of plant operators and is the site from which they control the plant in the event of an accident. To assure that the control room is habitable under all conditions, it must be able to withstand severe natural phenomena and to have self-sufficient environmental control systems and emergency power supplies. (4) In this respect the control room is not much different from other safety-related plant systems, but its design basis includes environmental qualifications for humans as well as for safety equipment.

The other key aspect of control room design is the layout and operability of the controls and instrumentation. This aspect is heavily influenced by human factors but has not been the subject of comprehensive regulatory guides or criteria. This is probably because control room layout was not considered to be safety-related, (5) at least until TMI.

NRC REQUIREMENTS BEFORE TMI

Appendix A to 10 CFR Part 50 contains General Design Criteria for Nuclear Powerplants. Criterion 13, Instrumentation and Control, and criterion 19, Control Room, bear on control room design.[1] By their nature, the General Design Criteria are broad statements of principles of nuclear safety and are so interpreted. Accordingly, it is possible to read into criteria 13 and 19 a basis for many specific requirements. However, because of their vagueness and the lack of any explicit reference to human factors, the criteria do not mandate attention to the interaction of control room design and operator performance.

Many additional regulatory requirements and guides have been issued to supplement the broad framework of the General Design Criteria. Three regulatory guides issued prior to TMI bear on human factors and control room design, but none were intended to address the issue comprehensively:[2] Regulatory Guide 1.47, "Bypassed and Inoperable Status Indication for Nuclear Powerplant Safety Systems"; Regulatory Guide 1.97, "Instrumentation for Light Water Cooled Nuclear Powerplants to Assess Plant Conditions During and Following an Accident"; and Regulatory Guide 1.114, "Guidance on Being Operator at the Controls of a Nuclear Powerplant."

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[1] *Criterion 13—Instrumentation and control.* Instrumentation shall be provided to monitor variables and systems over their anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions as appropriate to assure adequate safety, including those variables and systems that can affect the fission process, the integrity of the reactor core, the reactor coolant pressure boundary, and the containment and its associated systems. Appropriate controls shall be provided to maintain these variables and systems within prescribed operating ranges.

Criterion 19—Control room. A control room shall be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions, including loss-of-coolant accidents. Adequate radiation protection shall be provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 5 rem whole body, or its equivalent to any part of the body, for the duration of the accident.

Equipment at appropriate locations outside the control room shall be provided (1) with a design capability for prompt hot shutdown of the reactor, including necessary instrumentation and controls to maintain the unit in a safe condition during hot shutdown, and (2) with a potential capability for subsequent cold shutdown of the reactor through the use of suitable procedures.

[2] The report of the Senate Special Investigation noted that a design engineer with the architect-engineering firm that designed Three Mile Island Unit 2 had commented:

> that there were no regulatory guides or standards that dictated the design of control rooms. There were a minimum number of regulatory guides which had requirements which impacted on the control room design. (6)

Regulatory Guide 1.47 provides guidance on indicators in the control room of a bypass or inoperable status of a safety system. The intent of a bypass indication is to "aid the operator in recognizing the effects on plant safety of seemingly unrelated or insignificant events." (7)

Regulatory Guide 1.97 requires an analysis of what instruments are required to monitor the course of an accident:

> This provision could have conceivably given rise to a requirement for a task analysis. That is, a description of what functions need to be done . . . and what aids (including instrumentation) are needed to optimize the man-machine relationship.

However, this regulatory guide was not interpreted by the NRC or the industry to cover the use of a task analysis. (8) In any event, Regulatory Guide 1.97 had not been implemented at operating reactors by the time of the TMI accident. (9)

Regulatory Guide 1.114, in putting primary responsibility for safe operation of the plant on the operators, apparently assumed that the control room would be properly configured and the operator would be provided with all the aids needed to perform his job. (10)

It is clear that adequate regulatory guidance and criteria for control room design did not exist prior to TMI. These deficiencies had been raised repeatedly with the NRC and the nuclear industry. In fact, starting in 1972, a series of studies were conducted by Sandia Laboratories, the Aerospace Corporation and Lockheed Missiles and Space Co. (for EPRI) to assess control room design and operator performance. (11) These studies pointed to existing problems in control rooms, particularly with respect to human factors, and the lack of clear regulatory standards.

Apparently there was agreement among NRC staff that a regulatory guide on control room design was needed, (12) but because of other priorities and limited resources, one was not developed. (13) Shortly after the TMI accident, the ESSEX Corporation conducted a detailed review of the NRC's regulations, regulatory guides and standard review plan and "found no examples of criteria written with a clear intent to include human engineering considerations in the licensing and regulatory system." (14)

POST-TMI REGULATORY ACTIONS

The various postmortems that have now been performed on the Three Mile Island accident have produced a chorus of recommendations on the analysis and application of human factors in nuclear powerplant control rooms. They have called for a review of control room layout, instrumentation, alarms and lighting, improved diagnostic instrumentation, the incorporation of automatic monitoring of the status of plant systems and the development of systems for analyzing disturbances to enhance operator comprehension of reactor conditions. (15)

In response, the NRC staff has undertaken remedial action on several fronts. Shortly after the accident, the NRC's Lessons Learned Task Force [3] promulgated short-term recommendations for all operating plants and plants about to receive Operating Licenses. Several of the recommendations bear on control room design:

- Recommendations 2.1.3.b and 2.1.7.b require improved instrumentation to detect inadequate core cooling and indication of auxiliary feedwater flow to the steam generators. The need for the instrumentation is anchored in General Design Criterion 13.
- Recommendation 2.2.2.a requires limited access to the control room in the event of an emergency. This requirement was based on Regulatory Guide 1.114.
- Recommendation 2.2.2.b requires establishment of an onsite Technical Support Center. While not directed at the control room per se, it does act to enhance the operators' response by segregating them from other plant emergency response activities.

The Lessons Learned Task Force's short-term actions have been implemented at all operating plants. In addition, the NRC has compiled an Action Plan of long-term, comprehensive activities in response to the TMI accident. The elements of the plan relating to control room design are as follows: (16)

(1) *Review of control room design.*—The NRC is requiring all licensees of operating reactors and applicants for Operating Licenses to perform a detailed review of control room design to identify and correct deficiencies. The reviews will assess control room layout, the adequacy of information available to the operator, the arrangement and identification of important controls and instrumentation displays, the usefulness of audio and visual alarm systems, information recording and recall capability, lighting, and other human factors-related features that could affect operator effectiveness. Review guidelines to be used by licensees and evaluation criteria to be used by the NRC will be developed and issued to the licensees by the NRC, after the public has had an opportunity to comment.

The Offices of Nuclear Reactor Regulation and Inspection and Enforcement will audit the review process performed by licensees to identify any review deficiencies or the need for additional guidance. The two offices will also evaluate the completed reviews to determine the need for any further control room design modifications and the acceptability of implementation schedules.

The schedule for these activities was for the NRC to issue review guidelines by May 1980, final evaluation criteria by November 1980, and completion of NRC evaluations of control room design review reports by January 1982. As of June 1980, the guidelines had not been issued.

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[3] An interdisciplinary team of engineers and scientists from various offices of the NRC, set up under the Office of Nuclear Reactor Regulation. Its purpose was to identify and evaluate safety concerns arising out of the TMI accident.

(2) *Plant safety parameter display console.*—The NRC will require all licensees and applicants to install a safety parameter display system that will provide the operator with a minimum set of parameters that define the safety status of the plant. The system would indicate to the operator that acceptable limits on plant conditions are being approached or exceeded.

(3) *Safety system status monitoring.*—The NRC will require all licensee's and applicants not currently committed to the Regulatory Guide 1.47, "Bypassed and Inoperable Status Indication for Nuclear Powerplant Safety Systems," to assess the need for an automatic status monitoring system. Without such a system, administrative procedures such as tagging of controls in the control room and other discretionary actions must be relied on to verify the status of systems.

(4) *Control room design standard.*—The NRC will formalize in a regulatory guide design standards and criteria for control rooms. The schedule calls for issuance of the guide for comment by July 1981 and an approved guide by May 1982.

(5) *Improved control room instrumentation research.*—The NRC's Office of Nuclear Regulatory Research has proposed a number of new studies to enhance the performance of the control room operator. These studies would evaluate new instrumentation to provide improved operator-process communication (i.e., the use of lights, alarms, annunciators, etc. to indicate the status of plant systems); instrumentation to follow the course of an accident; an on-line reactor surveillance system, perhaps based on noise diagnostic techniques, to monitor certain plant signals for anomalies; new concepts in measuring parameters such as water level in the core, low primary system flow rates during natural circulation, and flow through relief valves; and the validity and possible application of computerized diagnostic systems for analyzing abnormal events in reactor systems.

NRC staff recommended that the above activities, with the exception of (3), be initiated in fiscal years 1980 and 1981. Item (3) was recommended for deferral until fiscal year 1982 or beyond. The Commission is considering these proposed actions.

CONCLUSIONS

On their face, the NRC's proposed activities, to the extent they mature into new regulatory criteria and are subsequently implemented at nuclear powerplants, are broadly responsive to the weaknesses that were apparent prior to TMI and reaffirmed by the accident itself. It is too early to predict the ultimate course that these activities will take. It is not the first time that many of the weaknesses in control room design and inattention to human factors have been identified. The Special Investigation staff had the feeling that this particular area is one where it is far easier to identify problems and to articulate needs than to translate them into an integrated package of hardware modifications. It is also an area where optimum control room design may not be susceptible to definition, and incrementally "better" designs may be the only realistically obtainable end product.

The action plan for control room design outlined by the NRC is ambitious. As it is the NRC's initial foray into this area of technology, there is no pre-existing regulatory infrastructure to inhibit or constrain the evolution of sound criteria and standards. On the other hand, it is inevitable that initiatives in this area will eventually conflict and interact with other regulatory policies, and a balancing of human and hardware elements will be required. (The most obvious example is tension between the need for separation of redundant electrical components and cabling in the control room for protection against failure of a single system and the need for having certain instruments and controls within close proximity for ease of operator manipulation.) The extent to which control room design can be afforded adequate human factors treatment may turn on the perceived necessity for enhanced operator response, if it must come at the expense of certain of the full complement of safety system requirements.

RECOMMENDATIONS

In addition to the above general observations are the following recommendations:

(1) A corollary to the need for explicit consideration of human factors in the establishment of regulatory criteria is that the NRC acquire staff expertise in this area. To date it has placed substantial reliance on contracting for this expertise with outside consulting firms. While contractors should remain a useful resource in the future, there is a clear need for knowledgeable staff within the NRC itself to provide balanced and informed determinations as to what licensing requirements should be and to review license applications against those standards. The formation of a Division of Human Factors Safety within the Office of Nuclear Reactor Regulation is a positive step.

There is a concomitant need for knowledgeable staff in the Office of Nuclear Regulatory Research to define and manage the research programs on control room design. It may also be useful to establish a separate unit within this office with exclusive jurisdiction over human factors-related research.

(2) It is evident from the numerous and varied initiatives in the area of human factors that careful attention must be paid to assure proper coordination of these efforts. New requirements for operator training, procedures, staffing, the establishment of onsite and offsite emergency support centers, increased reliance on computers and data links to regulatory agencies and nuclear vendors

all influence effective control room design, and vice versa. Therefore, the basic goals and objectives of operational safety [4] should remain clearly visible, and the extent and manner in which each program element contributes to the objective should be carefully monitored and integrated.

REFERENCES

1. Nuclear Regulatory Commission Special Inquiry Group, *Three Mile Island: A Report to the Commissioner and to the Public*, NUREG/CR-1250, Volumes I and II, 1980, Volume I, p. 123 (hereafter SIG Report).

2. For a discussion of the evolution of the design of the TMI-2 control room, see Subcommittee on Nuclear Regulation, *A Report to the Senate*, *Nuclear Accident and Recovery at Three Mile Island: A Special Investigation*, Senate Committee on Environment and Public Works, U.S. Congress, June 1980, pp. 50-76 (hereafter Nuclear Accident and Recovery Investigation), p. 125.

3. The President's Commission on the Accident at Three Mile Island, "Report of the Office of Chief Counsel on the Nuclear Regulatory Commission," October 1979, p. 73 (hereafter President's Commission NRC Task Force Report).

4. Regulatory Guide 1.78, "Assumptions for Evaluating the Habitability of a Nuclear Powerplant Control Room During a Postulated Hazardous Chemical Release," and Regulatory Guide 1.95, "Protection of Nuclear Powerplant Control Room Operators Against an Accidental Chlorine Release," NRC.

5. Op. cit., President's Commission NRC Task Force Report, p. 76.

6. Op. cit., Nuclear Accident and Recovery Investigation, p. 56.

7. Regulatory Guide 1.47, NRC, Section B.

8. Op. cit., SIG Report, Volume II, Part 2, p. 345.

9. Op. cit., President's Commission NRC Task Force Report, p. 76.

10. Op. cit., SIG Report, Volume II, Part 2, p. 345.

11. The studies are described in more detail in, op. cit., Nuclear Accident and Recovery Investigation, pp. 60-63.

12. The NRC's Human Engineering Research Review Group made this recommendation on the basis of the 1975 Sandia study of the Zion Nuclear Powerplant; see ibid., p. 31. The need for a regulatory guide was also echoed in a February 1977 study—see, ibid., p. 33.

13. Ibid., p. 35.

14. Op. cit., SIG Report, Volume II, Part II, p. 345.

15. The President's Commission on the Accident at Three Mile Island, *The Need for Change: The Legacy of TMI*, Final Report, October 1979, pp. 63, 72; op. cit., SIG Report, pp. 122-128; and Office of Nuclear Reactor Regulation, "TMI-2 Lessons Learned Task Force Final Report," NRC, NUREG-0585, pp. A-11 to A-13 (hereafter LLTF Report).

16. "NRC Action Plan Developed as a Result of the TMI-2 Accident," NRC, Draft 3, March 5, 1980, Section I.D.

17. Op. cit., LLTF Report, p. 2-2.

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[4] There are two complementary goals: minimizing the rate of challenges to plant safety systems and maximizing the capability to mitigate the challenges that inevitably occur. (17)

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TRAINING AND LICENSING OF NUCLEAR POWER REACTOR OPERATORS: AN ANALYSIS OF THE ROLE OF THE NUCLEAR REGULATORY COMMISSION

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PART I: THE ROLE OF THE NUCLEAR REGULATORY COMMISSION

As part of its responsibility in licensing nuclear power plants the Nuclear Regulatory Commission (NRC) has the authority to set and enforce minimum standards for the staffing of control rooms and the training of operating personnel. In addition, individual reactor operators are licensed by the NRC.

In the aftermath of the accident at Three Mile Island (TMI), the NRC has taken steps to increase the number of operating staff required, to improve the training of nuclear reactor operators, and to upgrade the testing and other requirements for issuance of operator's licenses. The NRC role in training and licensing is still in a state of flux. In the following section, the situation prior to TMI is described. 1/ The succeeding section discusses the post-TMI changes and trends.

Pre-TMI Role of the NRC

Statutory Responsibilities and Functions of the NRC in Licensing and Training

The statutory basis for the licensing of nuclear reactor operators comes from the Atomic Energy Act of 1954 requirement that the Atomic Energy Commission (AEC):

1. Prescribe uniform conditions for licensing individuals as operators of the facilities licensed under the Act;

2. Determine the qualifications of such individuals; and

1/ While the present tense will generally be used in describing regulations and procedures in effect prior to TMI, some of these have already been modified or are currently being reevaluated.

3. Issue licenses to such individuals in such form as the Commission may prescribe. 2/

These functions were transferred to the newly formed Nuclear Regulatory Commission by the Energy Reorganization Act of 1974. 3/

The regulations which have been developed by the AEC and NRC to govern the procedures and criteria for the issuance of operator and senior operator licenses and the requirements for operator requalification programs are set forth in Title 10 Part 55 of the Code of Federal Regulations (10 CFR 55), "Operators Licenses".

The statutory basis for NRC regulation of power plant staffing and of training programs for personnel, as well as the regulation of other aspects of power plant operations, comes from the facility licensing provision of the Atomic Energy Act of 1954, which stipulates that licenses shall be granted subject to such conditions as the [Atomic Energy] Commission may by rule or regulation establish to effectuate the purposes of the Act. 4/ These functions were transferred from the AEC to the NRC by the Energy Reorganization Act of 1974.

Regulations for the licensing of power plants are contained in 10 CFR 50, "Licensing of Production and Utilization Facilities". Paragraph 50.54 stipulates, among other requirements, that the controls of any nuclear facility may be manipulated only by individuals who are licensed operators in accordance with 10 CFR 55 and that a licensed operator be

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2/ Atomic Energy Act of 1954, as amended. P.L. 83-703, Sec. 107; 42 U.S.C. 2137.

3/ Energy Reorganization Act of 1974. P.L. 93-438; 42 U.S.C. 5801 et seq.

4/ Atomic Energy Act of 1954, as amended. P.L. 83-703, Sec. 103; 42 U.S.C. 2133.

present at the controls at all times during the operation of the facility. Paragraph 50.34 requires that applicants for nuclear facility operating licenses provide information concerning organizational structure, personnel qualifications, and related matters. This latter provision is the basis for NRC examination and approval of control room staffing, and operator selection criteria and training programs. A facility's plans for staffing, selection and training must be approved by the NRC before a construction permit will be granted and the implementation of these plans is examined before the NRC grants an operating license.

In addition to regulations, the Nuclear Regulatory Commission has compiled a number of licensing and regulatory guides. Compliance with the standards set forth in these guides is not required by law. However, the guides delineate the procedures and criteria used by the NRC staff in implementing the Commission's regulations. In general, regulatory guides set forth minimum standards, compliance with which will likely result in license approval without the need for extensive justification by the prospective licensee. Their prescriptions are nearly always followed by utilities. [5] However, if a licensee chooses not to follow the prescription in a particular regulatory guide, then it may still earn NRC approval if it provides a basis for the NRC staff to determine that the substitutions are acceptable.

Regulatory Guide 1.8, "Personnel Selection and Training", specifies acceptable practices for utilities to follow in the selection and training of personnel, including operators. Rather than detailing specific standards, Regulatory Guide 1.8 endorses a voluntary industrial standard approved by the American National Standard Institute (ANSI), Committee N18, Design Criteria for Nuclear Power Plants and the ANSI Nuclear Technical Advisory Board. This standard, designated ANSI N18.1-1971, is titled "Selection and Training of Nuclear Power Plant Personnel". 6/

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[5] See Part II of this report on industry contributions to training.

The "NRC Operator Licensing Guide" 7/ sets forth the procedures and criteria for the issuance of operator and senior operator licenses in accordance with 10 CFR Part 55 and describes the scope and content of operator license exams.

Information concerning reactor operator training is also contained in section 13.2 of Regulatory Guide 1.70, the "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants". 8/ The information contained in safety analysis reports (SARs), which are an important part of applications for licenses to construct or operate a nuclear power plant, allows the NRC to make determinations regarding the organization's ability to operate the plant in a safe manner. Regulatory Guide 1.70 describes the extensive information that must be contained in SARs and explains how this information is to be presented. Requirements for training programs are not included in this guide, rather it refers to Regulatory Guide 1.8, 10 CFR 55, and the Operator Licensing Guide for guidance. However, information on what must be included in SARs can be instructive as to what items are used by the NRC in making licensing

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6/ The standard was developed by the American Nuclear Society and is also referred to as standard ANS 3.1.

7/ U.S. Nuclear Regulatory Commission. Operator Licensing Branch. NRC Operator Licensing Guide; a Guide for the Licensing of Facility Operators, Including Senior Operators. Washington, the Commission, July 1976. 117 p. (NUREG-0094).

8/ U.S. Nuclear Regulatory Commission. Office of Standards Development. Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants; LWR Edition. Regulatory Guide 1.70, revision 3. Washington, the Commission. November 1978. Section 13.2. Training. pp. 13-5 - 13-9.

decisions. For example, in the training section it states that Final Safety Analysis Reports should include: 1) the subject matter of all training courses given, including a syllabus; 2) the approximate number of weeks a trainee is in full time attendence; 3) the organization teaching the course or supervising instruction; and 4) the position titles for which the course is given. 9/

A related document to Regulatory Guide 1.70 is the "Standard Review Plan". 10/ While this document was prepared primarily for the use of the staff of the Office of Nuclear Reactor Regulation to provide guidance to them in their review of SARs, it is publicly available. The Standard Review Plan specifies: 1) areas of review; 2) acceptance criteria; 3) review procedures; and 4) evaluations findings.

The arrangement of the Standard Review Plan is the same as that of Regulatory Guide 1.70. Chapter 13 covers the licensee's operating organization and section 13.2 of that chapter addresses training. In chapter 13 the specified areas of review generally duplicate the information given in Regulatory Guide 1.70 regarding what must be included in SARs, and the acceptance criteria section refers to the relevant regulations and regulatory guides. The review procedures of section 13.2 are also brief, specifying only that a review consists of determining that all the required information is submitted and comparing the information with the acceptance criteria. It does not give detailed instructions on how this is to be carried

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9/ Ibid., p. 13-6.

10/ U.S. Nuclear Regulatory Commission. Office of Nuclear Reactor Regulation. Standard Review Plan. Washington, the Commission. NUREG-75/087, continuously updated, 1590 p.

out. The evaluations findings section explains what the reviewer is to include in his/her report. It states that the report must be able to support a statement such as, "the training program and schedule for all staff members is acceptable for the preoperational test program, for operator licensing examinations, and for fuel loading." 11/

Plant Staffing Requirements for Licensed Operators

The NRC issues two types of operator's licenses. Anyone who manipulates reactor controls must be licensed as an "operator" and anyone who directs the activities of licensed operators must be a licensed "senior operator". 12/ Licenses are granted for a period of two years, after which they may be renewed. A license applies only to a specific facility, but an individual may be simultaneously licensed on more than one facility. As of March 31, 1980, 1,144 reactor operator's licenses and 1,535 senior reactor operator's licenses were current. 13/

The requirement for operator staffing of power plants in 10 CFR 50.54 is that one operator shall be present at the controls of a facility at all times and that a senior operator shall be present at the facility or readily available at all times during its operation and present during several specified conditions. However, the minimum shift requirements for a licensed single unit plant specified in the Standard Review Plan is one senior operator, two operators, and two nonlicensed auxiliary operators. 14/ This latter

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11/ NUREG-75/087. op. cit. p. 13.2-4.

12/ 10 CFR 50.54.

13/ Nuclear Regulatory Commission. Operator Licensing Branch.

14/ U.S. Nuclear Regulatory Commission. Standard Review Plan. NUREG-75/087. Section 13.1.2 Operating Organization.

standard was followed by the NRC prior to TMI and in practice most of the time there were two or more licensed operators in reactor control rooms. [15]

In addition to the above requirements for licensed operators, ANSI N18.1-1971 specifies that the Operations Manager of a plant shall hold a senior reactor operator's license and that the plant manager or his/her assistant shall have acquired the experience and training normally required for examination as a senior reactor operator, although the the examination need not be taken.

Operator and Senior Operator License Eligibility

The principal qualification for earning an operator's or senior operator's license is the passage of an examination administered by the Operator Licensing Branch of the Nuclear Regulatory Commission. However, before the examination will be administered, eligibility of the applicant based on an application submitted pursuant to 10 CFR 55.10 must be determined. The application must include the education and pertinent experience of the applicant, a report of a medical examination, and a request from an authorized representative of the facility licensee that the test be administered. The facility must certify that the applicant has a need for the license, has completed a training program, and has learned to operate the reactor controls competently and safely.

Applications are rarely denied by the NRC for deficiencies in education, experience or training or for medical reasons. However, the low rate of denial has been attributed to a prior screening of applicants by facility licensees. 16/ On at least one occasion a large group of applicants was required to undergo additional training before being allowed to take license examinations because their employer had omitted a portion of the required training program. 17/

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[15] U.S. Congress. General Accounting Office. Letter report to the Honorable Richard Schweiker on the Nuclear Regulatory Commission's Program for Licensing Nuclear Powerplant Personnel. May 15, 1979. (EMD-79-67) p. 13.

A summary of the educational, experience, training and medical requirements for operators and senior operators follows.

Education and Experience Requirements

The acceptable levels of education and experience specified in ANSI N18.1-1971 (and endorsed by the NRC in Regulatory Guide 1.8) for operators and senior operators are as follows:

Operators-

Education: High-school graduate or equivalent.

Experience: Two years of power plant experience or its equivalent, provided that a minimum of one year is at a nuclear power plant.

Senior Operators-

Education: High-school graduate or equivalent.

Experience: Four years of responsible power plant experience, of which a minimum of one year must be nuclear power plant experience. A maximum of two years of the remaining three years of power plant experience can be fulfilled by academic or related technical training on a one-for-one basis.

Experience is defined to mean actual applicable working experience in design, construction, startup, operation, maintenance, or technical services and to exclude observation of others performing applicable

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16/ Holman, Jerry J. Operator Licensing Branch. Nuclear Regulatory Commission.

17/ Ibid.

functions. There is no further qualification of responsible experience as required for senior operators.

Training Requirements

Operator's licence applications must include certification from the facility licensee that the applicant has completed a training program. NUREG-0094 specifies that this certification should include details on the courses of instruction attended, the number of course hours, the number of hours and the nature of training received at the facility and the reactor startup and shutdown experience received. However, this information is generally not used by the NRC to determine the sufficiency of training. Rather, facility training programs must be approved by the NRC when they are established and they are audited yearly as described below. The information on the license application serves only to document the applicant's participation in the required training program. 18/

License applicants from new facilities, at which nuclear fuel has not yet been loaded, must meet stricter training requirements than other applicants before the licensing examinations will be administered, because their examinations (called "cold" examinations and described below) cannot be as comprehensive as those at facilities which have loaded fuel.

Among the requirements which must be met for an applicant to be eligible for a cold examination, 10 CFR 55.25 specifies that the applicant must have extensive operating experience at a comparable reactor. The NRC Operator Licensing Guide 19/ states that this requirement is considered to be satisfied if:

18/ Nuclear Regulatory Commission. Operator Licensing Branch.

19/ NUREG-0094, op. cit., p. 13.

1. The applicant holds an operator's or senior operator's license at any other light water power reactor;

2. Certification is received from the facility management of a comparable unlicensed reactor facility (e.g., operated by the military services or the Department of Energy) that the applicant has the necessary operating experience; or

3. Certification is received from an NRC-approved training program, which utilizes a nuclear power plant simulator, that the applicant has satisfactorily completed the training program. [20]

Medical and Security Requirements

Applicants for operator's licenses must submit to the NRC a report of a medical examination by a licensed medical practitioner on NRC form NRC-396. [21] This form establishes the applicant's medical history as well as the results of a general physical examination. Paragraph 55.11 of 10 CFR 55 lists as sufficient cause for denial of an application: epilepsy, insanity, diabetes, hypertension, cardiac disease, fainting spells, defective hearing or vision, or any physical or mental condition which might cause impaired judgement or motor coordination. In practice, the NRC does not verify the applicant's statements on the medical history nor did it require any psychiatric screening of applicants prior to the Three Mile Island accident. 22/

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[20] The applicant must pass an examination administered on the simulator by the training institution to receive this certification.

[21] A sample of this form appears in NUREG-0094.

The NRC does not perform a security check on operator's license applicants. Applicants are required to provide the NRC with information on any convictions for violations of law resulting in a fine of $25 or more, but this information is not verified. 23/ NRC requirements for the security of nuclear power plants are set forth in 10 CFR 73, "Physical Protection of Plants and Materials". However, that regulation contains no provisions regarding the suitability of personnel other than members of the security force of the power plant.

License Examinations

In order to receive an operator's or senior operator's license 10 CFR 55.11 requires that, "The applicant has passed a written examination and operating test . . . to determine that he has learned to operate and, in the case of a senior operator, to operate and to direct the licensed activities of licensed operators in a competent and safe manner."

22/ Eytchison, R. Technical Staff Analysis Report to the President's Commission on the Accident at Three Mile Island; Selection, Training Qualification, and Licensing of Three Mile Island Reactor Operating Personnel. Washington, the Commission, Oct. 1979. p. 32.

Methods for certifying medical fitness, including psychological fitness, of operators have been specified in an industry standard adhered to by most power plants since 1976. This standard, ANSI N546-1976/ANS 3.4; "Medical Certification and Monitering of Personnel Requiring Operator Licenses for Nuclear Power Plants" was endorsed by the NRC in March 1979 in Regulatory Guide 1.134; "Medical Evaluation of Nuclear Power Plant Personnel Requiring Operator Licenses".

23/ Eytchison, R., op. cit., p. 32.

The required examinations are prepared, administered and evaluated by examiners from the Operator Licensing Branch of the NRC's Office of Nuclear Reactor Regulation.

Written Examinations

Twelve topics are listed in 10 CFR 55.21 for inclusion in the written examination for reactor operators. In practice, these have been regrouped into seven categories from each of which five to ten questions are asked on an examination. The categories are:

--principles of reactor operation;

--features of facility design;

--general operating characteristics;

--instruments and controls;

--safety and emergency systems;

--standard and emergency operating procedures; and

--radiation control and safety.

Examination questions are taken from a file of about 400 questions that have been asked on previous exams and are supplemented by questions made up by the examiner. Sample questions are listed in the Operator Licensing Guide (NUREG-0094). The examination is designed to be completed in under eight hours, however no time limit is imposed. [24]

Most questions ask the applicant to explain, describe, or sketch the function of various reactor systems or control features. The written examination, as administered prior to TMI has been criticized 25/ for not sufficiently questioning the applicants' understanding of the underlying theory of reactor design and for insufficient attention to thermodynamic principles and the importance of maintaining reactor core cooling.

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[24] Memo from Harold R. Denton to the Nuclear Regulatory Commissions on qualifications of reactor operators. July 30, 1979. SECY 79-330E. Enclosure 1; Results of a Review of Current NRC Requirements and Guidance to Licensees for Qualification of Reactor Operators. p. 29.

The written examination for senior reactor operators consists of the above seven categories plus an additional five categories consolidated from nine topics specified in 10 CFR 55.22. The categories are:

--reactor theory;

--radioactive materials handling, disposal, and hazards;

--specific operating chacteristics;

--fuel handling and core parameters; and

--administrative procedures, conditions, and limitations.

NUREG-0094 specifies that the reactor theory category will emphasize understanding and practical application of the theory rather than mere memorization of technical facts. The senior operator written examination is designed to be completed in five hours and again no time limit is imposed. 26/

Prior to the Three Mile Island accident, the passing grade on both operator and senior operator examinations was 70 percent. If an applicant passed, but had low scores in some categories, no formal provisions were made for retraining in these areas. However, the NRC would informally

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25/ Eytchison, R. op. cit., p. 30.

26/ SECY 79-330E, op. cit., p. 30.

notify the management of training programs of areas in which their trainees repeatedly received low scores. [27/]

Operating Test

The operating test, administered by an NRC examiner to each applicant individually, normally requires from four to six hours. It consists of an oral examination, a plant walk-through with a discussion of systems, and a demonstration at the reactor console.

The major portion of the operating test is the part conducted at the reactor console. Until 1976, all applicants, except those at facilities at which fuel had not been loaded ("cold" applicants) were required to actually manipulate the reactor controls of their facility's reactor through a startup and one or more additional changes in power level. Applicants for cold exams were required to have more training and experience than applicants for hot examinations, as described above, since they could only talk through the startup and indicate the controls and instrumentation used.

In 1976, the NRC determined that reactor shutdowns for operator testing were too costly to the facility licensee, and that the purposes of the operating test could be satisfied at reactor simulators. Procedures were changed so that applicants who have been at the facility for more than six months, have participated in plant operation at power levels of at least 20 per cent, and have successfully completed an NRC approved training program of at least one week duration at a nuclear power plant simulator, could take the operating examination without having to manipulate

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[27/] Holman, Jerry J. Nuclear Regulatory Commission. Operator Licensing Branch.

the controls of a live reactor. 28/ Since then, few applicants have actually manipulated reactor controls during operating examinations.

In addition to a demonstration of a reactor startup during the operating examination, the applicant's knowledge of how to operate the facility under emergency conditions is also questioned. This is accomplished by postulating symptoms of an incident to the applicant. From the symptoms, the applicant must determine the type of incident that has occurred and indicate the immediate actions required.

The operating test for reactor operator and senior reactor operator candidates is the same, except that NUREG-0094 specifies that a senior operator should display a higher degree of competence and more thorough knowledge and understanding than that required of an operator. No criteria are given in NUREG-0094 for determining this higher level of achievement. Operating tests do not result in a numerical grade, but rather the examiner fills in a report indicating satisfactory or unsatisfactory understanding of several dozen categories in ten broad areas and recommends passing or failing the individual. 29/

The operating examination is not required for a senior operator applicant who already holds an operator's license at the same facility. An applicant for a senior operator's license without an operator's license may fail at the senior operator level, but receive an operator's license if he/she

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28/ NUREG-0094. Appendix F. Eligibility for Examination With No Reactor Startup Demonstration.

29/ Denton memo SECY 79-330E, op. cit., p. 30.

passes the first seven parts of the written examination and the operating examination at the reactor operator level. 30/

Results of License Examinations

Statistics that have been compiled by the NRC of the results of license examinations from 1960 to 1978 31/ are shown in table 1.

TABLE 1 - NRC License Examination Results 1960 - 1978

	1960-1970	1971-1974	1975-1978
Operator Applicants	668	438	852
Denials (percent)	16.6	15.2	11.5
Senior Operator Applicants*	196	154	377
Denials (percent)	11.2	15.7	9.8
Senior Operator Applicants**	337	429	560
Denials (percent)	21.1	19.9	11.2

*With current operator's license
**Without current operator's license

It can be seen from the data presented in table 1 that the overall failure rate on license examinations was only about 11 percent in the most recent period compared to 17 percent in the period from 1960 to 1970. Examination of the more detailed data presented at the Gatlinburg Conference on nuclear facility personnel training 32/ shows that almost the entire change is due to lower failure rates on the written portion of the examination in

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30/ NRC Operator Licensing Guide; NUREG-0094, op. cit., p. 16.

31/ Holman, J.J. U.S. Nuclear Regulatory Commission License Examination Results Update 1975-1978. p. 30. In, Proceedings of the Third Symposium on Training of Nuclear Facility Personnel April 29 - May 2, 1979, Gatlinburg, Tennessee. Sponsored by Oak Ridge National Laboratory. Avail NTIS CONF-790404.

32/ Ibid.

the 1975 to 1978 period, compared to earlier years. For applicants for operator's licenses, the percent of all denials that were due only to failure of the written portion of the examination fell from 47 percent during 1960 to 1970 to 18 percent during 1975 to 1978. Eighty-three percent of all new license applicants who failed either portion of the examination in the most recent period failed the operating part of the examination. 33/

The fact that performance of applicants on the written portion of the examination has improved while performance on the oral part has remained constant could be due in part to increased familiarity among training institutions with the types of questions asked on the examination. It has also been charged 34/ that the NRC did not discourage the industry practice of teaching applicants to pass the examination. However, a representative of the NRC Operator Licensing Branch 35/ claims that the OLB did discourage this activity. The OLB pointed out that old examination questions were kept secret for this purpose and that on many occasions the OLB urged training institutions to teach their trainees how to operate reactors safely and predicted that if they did, then the applicants would have no difficulty passing the examination.

An applicant for a license who fails the examination may reapply two months later if the facility licensee certifies that the applicant

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33/ Ibid.

34/ Eytchison, op. cit., p. 33

35/ Holman, Jerry J. Nuclear Regulatory Commission. Operator Licensing Branch.

has had additional training and is ready for reexamination. A third application may be made six months following the second application and subsequent attempts to pass the examination may be made every two years.

The NRC Operator Licensing Branch

The primary function of the Operator Licensing Branch (OLB) of the NRC is to develop, prepare, and administer the written and operating examinations to operator and senior operator license applicants. In addition, it reviews safety analysis reports in areas related to plant staff training. The OLB reviews the organization's proposed method of training, requalifying and evaluating plant staff members and the proposed method of procedural control of operations in preliminary and final safety analysis reports. 36/

The OLB has worked with reactor vendor organizations and other training organizations, in addition to facility licensees, to develop training programs sufficient for licensing purposes. Minimum standards for training programs are described in the following section.

In addition to the above duties, the OLB also audits the operator requalification program examinations given by the training staffs at operating nuclear facilities.

At the time of the Three Mile Island accident, the Operator Licensing Branch had 8 full time examiners and 22 part-time examiners to carry out

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36/ SECY 79-330E, op. cit., p. 46.

all license examinations, safety analysis report reviews, and requalification program audits. 37/

The full-time examiners have generally had many years of operating experience at national laboratories, commercial power plants or military reactors and several years of experience in training operators. 38/ However, they are not required to hold operator's licenses and only three have ever been licensed operators at commercial nuclear power plants. 39/

About half of the part-time examiners are employed at national laboratories and the other half are university faculty members. Many of them have operated only research reactors. 40/ However, OLB has stated that their theoretical knowledge combined with OLB training programs and review of their work by experienced examiners makes the use of knowledgeable part-time examiners appropriate. According to the OLB, the staffing objective has been to accommodate 80% of the expected workload with full-time personnel and employ part-time examiners to adapt to work load fluctuations in an efficient and expeditious manner. 41/

After a training program, which includes observing an experienced examiner prepare and administer written and operating examinations, new examiners prepare and administer an examination on a similar reactor under the specific guidance of a senior examiner. New examiners continue

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37/ Eytchison. op. cit., p. 34.

38/ SECY 79-330E, op. cit., p. 47.

39/ Eytchison, op. cit., p. 34.

40/ Ibid.

41/ SECY 79-300E., op. cit., p. 48 and 49.

to receive guidance from senior examiners until their capabilities have been demonstrated. The training of part-time examiners extends over a longer time period and they receive closer supervision than permanent staff. 42/

NRC Approval of Operator Training Programs

The Nuclear Regulatory Commission reviews the plans for the training of facility personnel contained in safety analysis reports before granting an organization a permit to begin construction or a license to operate a nuclear facility. However, as documented below, the requirements for acceptable training programs for reactor operators were not well defined in written form prior to the Three Mile Island accident.

Section 13.2 of the NRC Standard Review Plan (NUREG-75/087), which sets forth NRC procedures for the review of safety analysis reports, gives the Operator Licensing Branch the responsibility to determine the overall acceptability of the applicant's plant staff training plans.

The general acceptance criteria set forth in the Standard Review Plan is that, "The safety analysis report should demonstrate that the training provided, or to be provided, for each position on the plant staff will be adequate to provide assurance that all plant staff personnel qualification requirements will be met as of the time needed." Regulatory Guide 1.8, 10 CFR 55, and the Operator Licensing Guide (NUREG-0094) are referenced in the standard review plan for the specific criteria for acceptability for training. However, none of these publications discuss the content or nature of training programs except for noting that the subjects that are included

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42/ Ibid., p. 48.

in the operator's license examinations should be included in training programs and that one of the acceptable criteria for being administered a "cold" examination is completion of an "NRC-approved training program which utilizes a nuclear power plant simulator." No further definition of an NRC-approved training program is given.

While there are no written criteria for approval of training programs, the Operator Licensing Branch (OLB) worked with reactor vendors and facility licensees in developing their training programs and approval was given to training programs only when the OLB believed that these programs would be adequate. The principal criteria used by the OLB to evaluate operational training programs was the performance by applicants from a particular program on licensing examinations. 43/ If graduates of a training program could pass the examinations, then they were considered well trained.

Some minimum requirements that were used by the OLB in determining the adequacy of initial training programs are briefly summarized in the July 30, 1979 memo from Harold Denton to the NRC Commissioners (SECY 79-330E). For applicants for cold examinations a four phase training program is described, which includes:

1. Twelve weeks of training in basic reactor fundamentals and at least ten startups of a research reactor;

2. Six weeks of lectures on the design features of the specific plant;

3. One to two months of observation of the day-to-day operation of a nuclear power plant and two to three months of operation of a nuclear power plant simulator; and

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43/ SECY 79-330E, op. cit.

4. One year of on-the-job-training and classroom study including construction check-out activities and preoperational testing.

The four phase training program is described more fully in part II of this report on the role of industry in training.

The review of NRC training requirements by the staff of the President's Commission on the Accident at Three Mile Island 44/ noted several deficiencies with the NRC approval of training programs. In addition to pointing out the lack of formal acceptance criteria, the Commission noted that the NRC did not license or even examine the qualifications of training instructors, nor did it monitor attendance at training courses. In addition, applicants from plants which had loaded fuel were not required to undergo any simulator training and there were no guidelines for what should be included in simulator training programs.

Prior to the accident at Three Mile Island, the only written NRC performance criteria for reactor simulators appeared in Appendix A of 10 CFR 55, which gives the requirements for requalification programs. It states that simulators used in requalification programs "shall accurately reproduce the operating characteristics of the facility involved and the arrangement of the instrumentation and controls of the simulator shall closely parallel that of the facility involved." The NRC did not have a regulatory guide which further specified the requirements of simulators, nor were there any requirements for the qualifications of the training staff at simulators.

44/ Eytchison, op. cit.

Requalification and Renewal of Operator's Licenses

Licenses for reactor operators and senior operators are of two years duration. Licenses may be suspended or revoked if the NRC finds that the operator has committed any conduct determined to be a hazard to the safe operation of the facility. However, only one operator's license has ever been suspended. 45/

In accordance with the provisions of 10 CFR 55.33, license renewals are granted if the physical health of the license holder is maintained and the facility licensee certifies that the operator has discharged his/her responsibilities competently and safely, and is capable of continuing to do so, and the operator has completed a requalification program. The NRC may require the applicant for renewal to retake the written examination or operating test. However, the facility licensee certification is nearly always sufficient for renewal, as only six operators have ever been required to be reexamined. Reexaminations have generally been required only when it was found that an operator commited a deliberate and willful act in violation of NRC regulations. 46/

The requirements for approved requalification programs are a little more firmly established by regulation (Appendix A of 10 CFR 55) than those for initial operator training programs. Among the requirements, Appendix A of 10 CFR 55 specifies nine topics to be covered in a regularly scheduled program of lectures required for a requalification

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45/ GAO report EMD-79-67. op. cit., p. 12.

46/ Ibid.

program. It also calls for on-the-job training which includes at least ten manipulations of reactor controls involving changes in power level, a review of abnormal conditions and emergency procedures, and an annual written examination administered by the facility licensee.

The NRC Operator Licensing Branch evaluates facility licensee requalification programs in its review of safety analysis reports. Additional criteria for approval beyond those of Appendix A of 10 CFR 55 are unwritten, but generally attendance at sixty hours of training lectures per year are required of operators and an annual oral examination, in addition to the written examination, is required. These examinations are to be patterned after the NRC licensing examinations. Anyone who scores lower than 80 percent in a category on the written examination is required to attend a lecture on that subject. If a person scores less than 70 percent in the written examination or is unsatisfactory in the oral examination, he/she must go into an accelerated training program. Most approved requalification progams require that an operator who has gone into accelerated training be relieved of his/her duties. In all cases, if an operator fails both the written and oral examinations, then he/she may not perform duties associated with reactor control until retraining has been completed. 47/

Simulator training in abnormal situations and emergency procedures was not a requirement of requalification programs at the time of the Three Mile Island accident.

47/ Eytchison, op. cit., p. 36.

NRC Inspection and Enforcement Activities Relating to Operator Training

NRC oversight of operator training programs is split between the Operator Licensing Branch (OLB) of the Office of Nuclear Reactor Regulation and the Office of Inspection and Enforcement (IE). While OLB is responsible for evaluating and approving facility licensee plans for training programs, IE is responsible for seeing that the approved plans are followed. The OLB uses the license examinations and audits of requalification examinations to determine that training is adequate.

In annual visits to power plant sites, regional inspectors from IE examine facility licensee records of training and requalification programs following procedures in sections 41.700 and 41.701 of the Inspection and Enforcement Manual. They check schedules of course offerings, lesson plans, attendance records, results of requalification exams, records which show that operators certified for requalification have performed the required number of control manipulations, and other records which enable them to determine whether the licensee is complying with their approved operator requalification program.

At the time of TMI, no effort was being made by the inspectors to determine the adequacy and effectiveness of the facility licensee's training programs. IE confined itself to determining whether proscribed procedures were being followed. 48/

Inspectors file formal reports of their findings with the facility licensee. When they find that the required procedures have not been followed an "item of non-compliance" is issued. The licensee is required to respond

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48/ Nuclear Regulatory Commission. Office of Inspection and Enforcement.

to the item of non-compliance within 20 days with its plans to address the issue. Generally, inspections at new plants before the Three Mile Island accident resulted in about two or three items of non-compliance related to training programs, and fewer were found in older plants where the licensee had become more familiar with the requirements. 49/ A typical item of non-compliance would involve a finding that an operator who had failed a portion of the requalification examination had not been re-examined or had not attended the required lecture covering that topic.

The OLB considers the results of the operator and senior operator license examinations as audits of the training programs. 50/ Facility and vendor training staffs are notified by the OLB of weak areas in their programs which are identified from the results of examinations. OLB examiners also visit facilities once every two years to audit the requalification examinations to see that they are comparable to the NRC licensing examinations in depth and content, and to see that the grading is also comparable. OLB also audits quizzes administered as part of the lecture series of requalification programs during these visits. In addition, any changes in training programs must be approved by the OLB.

Enforcement actions against operators who act in an unsafe manner are the responsibility of IE. However, prior to the Three Mile Island accident, the policy of IE was to cite the facility licensee for operator errors when the event resulted from inadequacies in the training program.

49/ Kellogg, Paul. NRC Office of Inspection and Enforcement. Region II office.

50/ SECY 79-330E, op. cit., p. 17.

IE would only act against an operator who knowingly or repeatedly committed an act of potentially significant safety consequences. [51]

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[51] SECY 79-330E, op. cit., p. 60.

Post-TMI Changes and Trends

Findings of the Major Reports on TMI

All of the major investigations into the causes of the Three Mile Island accident [52] determined that the accident would have been a minor incident had the operators taken the proper actions. Many deficiencies in the experience, training and licensing of nuclear power plant operating staff were identified by these investigations as possible contributors to the operators' inability to act correctly, and recommendations were made to correct these deficiencies.

Some of the major findings of the TMI investigations regarding power plant operators are summarized below. The NRC has addressed virtually all of the recommendations of the major investigations. These NRC actions are described in the following section with references given to the reports of the investigations for the specific recommendations addressed.

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[52] President's Commission on the Accident at Three Mile Island, John Kemeny Chairman. Report of the Commission; The Need for Change: The Legacy of TMI. Washington, U.S. Govt. Print. Off., 1979, 201 p. (Kemeny Report).

U.S. Nuclear Regulatory Commission. Special Inquiry Group., Mitchell Rogovin, Director. Three Mile Island; A Report to the Commissioners and to the Public. Washington, the Commission., 1980, 2 vols. in 4 parts. NUREG/CR-1250. (Rogovin Report).

U.S. Nuclear Regulatory Commission. Office of Nuclear Reactor Regulation. TMI-2 Lessons Learned Task Force Status Report and Short-Term Recommendations. Washington, the Commission., July 1979, 1 vol. in various pagings. (NUREG-0578).

U.S. Nuclear Regulatory Commission. Office of Nuclear Reactor Regulation. TMI-2 Lessons Learned Task Force Final Report. Washington, the Commission., Oct. 1979, 1 vol. in various pagings. (NUREG-0585).

U.S. Nuclear Regulatory Commission. Office of Inspection and Enforcement. Special Review Group. Report on Lessons Learned from Three Mile Island. Washington, the Commission., Dec. 1979, 160 p. plus appendices. (NUREG-0616).

Kemeny report

The 12 member President's Commission on the Accident at Three Mile Island (Kemeny Commission) was a high level independent commission appointed by President Carter to conduct a comprehensive study and investigation of the accident. The Commission presented 5 multi-part findings regarding the training of operating personnel and 4 recommendations to improve that training. 53/ Included in their findings was the determination that the "training of Met Ed operators and supervisors was inadequate and contributed significantly to the seriousness of the accident." They further found that, "NRC standards allowed a shallow level of operator training". Specifically, the President's Commission found that: 1. the NRC prescribed only minimal requirements for operator training; 2. an individual could fail part of the licensing exam and still qualify to operate the reactor; 3. the NRC had no criteria for determining the qualifications of training instructors; and 4. the NRC did not conduct regular in-depth reviews of training programs. 54/

Two of the Staff Reports to the President's Commission on the Accident at Three Mile Island 55/ had additional findings and recommendations

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53/ Kemeny Report op. cit. pp. 49-50 and 70-71.

54/ Kemeny Report op. cit. p. 49.

55/ Eytchison, R., Selection, Training, Qualification, and Licensing of Three Mile Island Reactor Operating Personnel. In, Reports of the Technical Assessment Task Force, Vol III. Washington, U.S. Govt. Print. Off. to be published.

Report of the Office of Chief Counsel. The Nuclear Regulatory Commission. Washington, U.S. Govt. Print. Off. to be published.

regarding the selection, qualification, training and licensing of reactor operating personnel which were not all adopted into the full Commission report.

Rogovin report

A Special Inquiry Group of the NRC was established to assess the accident at TMI and determine what happened and why, and to identify deficiencies in the system that enabled the accident to happen. The group's work was mostly conducted by NRC staff, but it was directed by Mitchell Rogovin, a Washington lawyer with no prior connection with the NRC. The Special Inquiry Group found that, "The inadequate training that played a role in this accident must be attributed not to one utility, but rather to the industry as a whole and to the NRC." They also found that licensing examinations "do not even measure operator ability accurately, much less ensure that an operator [can] operate a reactor safely . . . only adequate training can do that." 56/ Additional findings and recommendations regarding reactor operators appear in several places throughout both volumes of the report.

Lessons Learned Task Force

The Lessons Learned Task Force was an interdisciplinary team established within the NRC Office of Nuclear Reactor Regulation to identify and evaluate safety concerns originating from the accident at TMI. This team produced a list of short-term actions to be taken at operating plants, and those with pending license applications, in a report issued in July 1979, 57/ and then issued a second

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56/ Rogovin Report op. cit. p. 102-103

57/ NUREG-0578 op. cit.

report dealing with safety questions of a more fundamental policy nature regarding nuclear plant operations and design, as well as the regulatory process, in October 1979. 58/

The task force concluded that, "The primary deficiency in reactor safety technology identified by the accident was the inadequate attention that had been paid by all levels and all segments of the technology to the human element and its fundamental role in both the prevention of accidents and the response to accidents." 59/

Two recommendations concerning operators were contained in the short term lessons learned report (NUREG-0578) and another ten were included in the final report (NUREG-0585)

NRC internal memo SECY 79-330E

The Office of Nuclear Reactor Regulation presented the results of its own review of the NRC operator licensing program to the Commissioners in a memorandum dated July 30, 1979. 60/ An appendix to that memorandum described the operator licensing program and set forth twenty-three detailed options for modifications to that program. Sixteen recommendations for action in the areas of eligilility and training, operator requalification programs, NRC examinations, and the use of nuclear power plant simulators were presented to the Commissioners.

Many of the initiatives in the area of operator training and licensing set forth in the NRC Action Plan to respond to TMI (discussed below) were developed from the options presented in SECY 79-330E.

58/ NUREG-0585 op. cit.

59/ Ibid. p. 1-2.

60/ Memorandum from Harold R. Denton, director, NRC Office of Nuclear Reactor Regulation to the NRC Commissioners, dated July 30, 1979, on the subject of qualifications of reactor operators. 7p. plus appendices. Available from the Commission (SECY 79-330E).

NRC Response to TMI

In order to coordinate its response to the lessons learned from TMI, the the NRC has developed an Action Plan "to provide a comprehensive and integrated plan for the actions now judged necessary by the Nuclear Regulatory Commission to correct or improve the regulation and operation of nuclear facilities based on the experience from the accident at TMI-2 and the official studies and investigations of the accident."61/

For each of the approximately 180 action items presented, the plan describes the objective of the item, the NRC action required, the industry action required, and an estimate of the schedule and resource requirements for implementation. About twenty of the action items deal directly with the staffing requirements, qualifications, training, and licensing of reactor operating personnel.

The entire Action Plan has not yet been formally approved by the NRC Commissioners. However, the plan was developed through four drafts which received substantial input from the Commissioners and the NRC offices concerned with each part of the plan. The nuclear industry was also given an opportunity to comment on a draft version of the plan. While changes will probably be made regarding some of the prescriptions given in the plan, especially those that involve rulemaking procedures and public comment, the Action Plan is a comprehensive statement of NRC plans, as of May 1980, to respond to the lessons learned from the Three Mile Island accident.

The Action Plan calls for new requirements relating to reactor operators to be incorporated into 10 CFR 50, 10 CFR 55 and the relevant standards, regulatory guides and operating manuals. However, such changes require lengthy

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61/ U.S. Nuclear Regulatory Commission. NRC Action Plan Developed as a Result of the TMI-2 Accident. Washington, the Commission, May 1980, 2 vols. (NUREG-0660). Vol. 1, p. 1.

review procedures, including opportunities for public comment. In the interim, some changes have already been implemented by modifications to NRC procedures and the issuance of bulletins and orders to power plant licensees; others will become effective upon approval of the relevant section of the Action Plan by the NRC Commissioners; and, still others, which require further definition of scope may be implemented through separate Commission actions.

Changes in operating staff requirements

According to item I. A.1(4) of the Action Plan, the NRC Office of Standards Development will conduct a thorough review and rulemaking procedure to amend the requirements of 10 CFR 50 regarding the number of operators who must work each shift and the number who must actually be present in the control room at all times. In the interim, the NRC has established the requirement that a senior reactor operator shall be in the control room at all times in addition to the single reactor operator previously required. This change necessitates increasing the minimum number of senior operators on shift from one to two.

Operating reactors must submit a plan for meeting the new personnel requirements by August 1, 1980. The requirements are to be implemented as soon as practible, but the NRC may give operating facilities until July 1, 1982 to do so in order to allow them sufficient time to recruit and train the additional licensed personnel that will be needed. However, new facilities receiving operating licenses before July 1, 1982 will be required to meet the increased staffing levels upon the loading of fuel into the reactor. 62/

In establishing final standards for control room personnel staffing, the NRC will consider requiring two reactor operators and a senior operator in the

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62/ NUREG-0660 op. cit. p. I.A. 1-5.

control room at all times, and mandatory walking tours and status checks of the plant by operators normally assigned to the control room. 63/

These changes in staffing requirements are in accord with recommendation 2 of the Lessons Learned Task Force Final Report (NUREG-0585) and with one of the recommendations of the Rogovin Report. 64/

In addition to increasing the number of operating personnel required, the Lessons Learned Task Force recommended 65/ that the position of shift technical advisor be established and added to the power plant staff required on all shifts in order to improve the technical and analytical capability available to control room operators.

In a letter issued by the NRC September 13, 1979, operating power plants were ordered to establish and staff such a position by January 31, 1980. However, the personnel in these positions are not required to be fully trained until January 1, 1981.

The shift technical advisor is required to have a bachelor's degree or equivalent in a scientific or engineering discipline and to receive specific training in the response and analysis of the plant to abnormal conditions and accidents. The shift technical advisor shall also receive training in plant design and layout, including the instrumentation of the control room. However, it is not required that the individual be a licensed operator, as these personnel are to have no responsibilities for the manipulation of controls. 66/

63/ NUREG-0660 op. cit. p. I.A. 1-3.

64/ Rogovin Report op. cit. p. 106.

65/ Recommendation 2.2.1.b, NUREG-0578 op. cit. p. A-49

66/ NUREG-0578 op. cit. p. A-50 - A-51.

The duties of the shift technical advisor, in addition to being available to provide technical expertise, shall involve assuring safe operations of the plant, and shall include the review and evaluation of operating experience. 67/

Changes required in operators' qualifications and training

The NRC is implementing both short-term and longer-term actions to upgrade the qualifications and training of operators. Many of the long-term changes will confirm to a draft revision of ANS 3.1 dated December 6, 1979. 68/ The NRC has taken steps to endorse this standard even though it may undergo further revisions and has not yet received final approval from the American Nuclear Society or the American National Standard Institute. The December 1979 draft of ANS 3.1 is endorsed by the NRC in a draft revised version of regulatory guide 1.8 which has been prepared and is to be published for public comment in June 1980. Further revisions to ANS 3.1 will be factored into regulatory guide 1.8 as they are established.

In the long-term, the NRC will phase in the requirement that applicants for operator's and senior operator's licenses meet the considerably upgraded standards of education and experience specified in the final version of ANS 3.1. The final requirements have not yet been established, however, according to the Action Plan, they will include the recommendations of NUREG-0585 that a bachelors degree or equivalent be required for senior operators and one to two additional years of experience in nuclear plants be required for both operators and senior operators. 69/

67/ Ibid.

68/ Standard for Qualification and Training of Personnel for Nuclear Power Plants; Proposed American National Standard. La Grange Park, Ill., American Nuclear Society. ANSI/ANS-3.1 Dec. 1979. 38 p.

69/ NUREG-0585 op. cit. p. A-7.

In the short-term, the NRC has adopted the levels of experience for senior reactor operator's license applicants specified in recommendations 1 and 2 of SECY 79-330E. Effective May 1, 1980, senior operator applicants shall be required to have two years of experience in a nuclear plant rather than one, and at least six months of this experience must be in the plant in which he/she seeks a license. The existing requirement for four years of "responsible" power plant experience has been clarified to mean a control room operator or plant staff engineer involved in the day to day activities of the plant. In addition, effective December 1, 1980, there will be a new requirement for an applicant for a senior reactor operator's license to have held an operator's license for one year. The minimum qualifications for reactor operators are not changed. 70/

In the area of training, several steps are being taken by the NRC to increase the amount of practical experience received by operators. The first ste is a new requirement, which will become effective August 1, 1980, that applicants for both operator's and senior operator's licenses shall have three month of training as an extra person on shift in the control room. 71/ The NRC is also expected to require that, after receiving licenses, operating personnel participate in in-plant drills. These drills will consist of walk-throughs of maneuvers to be taken in response to abnormal or accident conditions. The NRC will issue short-term requirements for facility licensee programs of in-plant drills by January 1981. 72/

70/ NUREG-0660 op. cit. p. I.A.2-1.

71/ NUREG-0660 op. cit. p. I.A.2-2.

72/ Ibid., p. I.A.2-5.

In the long term, the Action Plan calls for 10 CFR 55 to be modified to require simulator training for all license applicants rather than just for cold applicants. In addition, some of the examinations that are currently administered by the simulator training institutions to certify that license applicants have passed the training program will be administered by the NRC in the future as a check against the quality of these programs. 73/

The NRC is also increasing its oversight of personnel training programs. The Action Plan specifies that the Office of Nuclear Reactor Regulation is to develop criteria and procedures to be used in the auditing of licensee and other training programs. 74/ These audits will examine the quality of training programs rather than just insuring that approved plans are being followed as is currently the case. As part of the audit, instructors in the training programs will be evaluated on their technical knowledge and their ability to teach. In addition, they will be required to hold or have held operator's licenses and to participate in requalification programs, or to possess instructor certification from an instructor training program approved by the NRC. 75/

In addition, steps are being taken to make the criteria for NRC approval of training programs more explicit than has been the case and to upgrade these criteria. The December 1979 draft of ANS 3.1 lists in considerable detail the subjects that should be covered in the classroom instruction phase of training programs. Among the subjects listed is specific training in the fundamentals of thermodynamics and fluid flow;

73/ Ibid., p. I.A.2-6.

74/ Ibid., p. I.A.2-4.

75/ Such an instructor certification program is expected to be conducted by the Instutute of Nuclear Power Operations (INPO).

elements that were previously identified as lacking from training programs. In addition, specific requirements are stated for trainees to observe plant operation, and to receive operating practice and simulator training. An Appendix to the standard describes a one year training program (one-and-one-half years for cold applicants) for license candidates with no prior reactor operating experience. The training standards specified in ANS 3.1 will represent a minimum program that will receive NRC approval upon endorsement of the standard by the NRC in regulatory guide 1.8 as is suggested in the Action Plan. 76/

The changes in NRC requirements for the qualifications and training of operating personnel described in the above section address recommendations C.1, C.2, and C.3 of the Kemeny Report; recommendations 1.2, 1.3, 1.4, and 1.6 of NUREG-0585; recommendations on pages 105 and 146 of the Rogovin Report; and several recommendations of SECY 79-330E.

Changes in licensing exams and requalification programs

The NRC has taken several steps to improve the utility of the licensing examinations as a means of ensuring that licensed operators can perform their duties in a safe manner. One change already instituted has been to raise the passing grade on the written examination to 80% overall with a minimum of 70% in each category. If these criteria are applied to the results of examinations taken between January 1977 and March 1979, 49% of the operator's license applicants and 40.3% of the senior operator's license applicants would

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76/ NUREG-0660 op. cit. p. I.A.2-6.

receive failing grades, as opposed to failure rates of 5.7% and 4.1% respectively, with the straight 70% passing grade previously required. 77/

The NRC has also added, as of May 1, 1980, a category covering thermodynamics, fluid flow and related areas to both the operator and senior operator written examinations; established time limits for applicants to complete the exams; and now requires that all senior operator applicants take the oral examination. 78/

According to the Action Plan, the NRC will also require, effective June 1, 1980, that performance at a nuclear power plant simulator be a part of oral license examinations at facilities where there is a simulator, and of all oral examinations in FY 1981. In addition, the NRC plans to begin to release results of all examinations to the facility management. This will provide direct feedback to the utilities regarding weaknesses in their training programs and allow facilities to administer additional training to the individuals concerned. 79/

Changes are also planned for operator requalification programs. Plans to establish a mechanism for identifying individuals who commit operational errors leading to events which must be reported to the NRC 80/

77/ SECY-79-330E op. cit. p. 34. It is possible that the failure rate would not have actually been this large if the higher passing grade had been in effect, since training and evaluations by facility management may have been altered.

78/ NUREG-0660 op. cit. p. I.A.3-1.

79/ Ibid.

80/ About 10 percent of the forty to fifty reportable events (LERs) per year from the average plant are attributable to operator errors. see, Scott, R.L. and R.B. Gallaher. A Review of Safety-Related Events at Nuclear Power Plants as Reported in 1978. Nuclear Safety, vol. 21, no. 1, p. 100-109. Jan.-Feb. 1980.

and to act on such errors with respect to continuation of licensing are expected to be developed beginning in FY82. 81/

The NRC is also considering increasing the requirements for requalification programs by stipulating that all licensees must participate on a yearly basis in retraining and recertification on a full scope simulator representative of their facility. Some of the examinations necessary for recertification may be administered by NRC personnel as a check against the quality of the simulator certification programs. In addition, the NRC plans to administer some or all of the full requalification exams to increase the level of confidence in the effectiveness of requalification programs. These steps are planned to take effect no later than September 1981, with the revision of 10 CFR 55. 82/

In order to improve the administration of the operator licensing program, the NRC is considering changes in the required qualifications and training of all of its examiners. Plans call for the development of formal training and retraining programs which include the use of simulators. 83/ Since part-time examiners are expected to be required to participate in this training, a minimum commitment for work and training of 55 days per year may be required of part-time examiners. 84/ Consideration is also being given by the NRC to the use of personnel that are employed full-time by utility and reactor vendor training staffs as part-time NRC examiners to administer requalification exams and simulator training certification exams. This would

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81/ Ibid. p. I.A.3-2.

82/ Ibid. p. I.A.2-7.

83/ Ibid. p. I.A.3-2.

84/ SECY 79-330E op. cit. p. 50.

allow the NRC to instruct them as examiners and maintain control over their requalification activities, but take advantage of the involvement of these individuals with the utility and vendor training programs in order to provide feedback to improve these programs. 85/

In addition to the above changes regarding license examiners, and in response to recommendation 1.4(7) of the final report of the Lessons Learned Task Force, the NRC will develop and implement a plan to locate Operator Licensing Branch (OLB) examiners at nuclear power plant simulator training centers and in regional inspection and enforcement offices as soon as personnel is available. 86/

One step already taken with regard to the Operator Licensing Branch, was to include it in a Division of Human Factors Safety created in a general reorganization of the Office of Nuclear Reactor Regulation announced in March 1980. 87/ The other branches included in the new division are the Human Factors Engineering Branch, which will develop criteria for control room design, emphasizing the man/machine interface; the Procedures and Test Review Branch, which will concentrate on control room procedures; and the Licensee Qualifications Branch, which is developing criteria for evaluating management structure and capabilities regarding operations. While the reorganization did not directly affect OLB responsibilities, the new division is a sign of the increased NRC emphasis on human factors resulting from recommendations of the TMI investigations.

85/ Ibid. p. 52.

86/ NUREG-0660 op. cit. p. I.A.3-2.

87/ Strong Project Management at Heart of NRR Reorganization. Inside N.R.C. April 7, 1980, p. 7-12.

The initiatives discussed above address recommendations C.2 and C.3 of the Kemeny Report, recommendation 1.4 of NUREG-0585, recommendation 2.4.4-5 of NUREG-0616, recommendations on pages 110 and 146 of the Rogovin Report, and several recommendations of SECY 79-330E.

Changes regarding simulator use and development

As already mentioned, the NRC plans to require that the use of reactor simulators be a part of all operator training and requalification programs. The NRC is taking several steps to develop the technology of reactor simulators and to establish and sustain a high level of realism in their use in training and retraining of operators.

The Offices of Nuclear Reactor Regulation and Nuclear Regulatory Research are collaborating on a short-term study to collect and develop corrections for the presently identified weaknesses of training simulators. The Action Plan states that, based on the results of this study, the NRC will require that specific weaknesses be corrected in the simulators used to train licensed operators. The Action Plan calls for the study to be completed by July 1980 and for the requirements for interim changes in training simulators to be issued by December 1980. 88/

The long-term requirements for reactor simulators will be specified in a standard being developed by the American Nuclear Society with input from the NRC. This standard, titled "Nuclear Power Plant Simulators for use in Operator Training" and designated ANS 3.5, was most recently revised in draft form in March 1980. The revision of ANS 3.5 is scheduled to be completed in December 1980. A regulatory guide endorsing the standard

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88/ NUREG-0660 op. cit. p. I.A.4-1.

is expected to be issued for comment by August 1980 and is planned to be in effect by September 1981. 89/

ANS 3.5 establishes the minimal functional requirements for nuclear power plant simulators for use in operator training. Criteria are set for the degree of simulation, performance, and functional capability of the instrumentation and controls. The general requirement for simulators as stated in the standard is to "provide complete and accurate simulation of control room equipment, plant systems, and plant operation as described ... The extent of simulation shall allow the operator to fully participate in appropriate plant evolutions and permit control of unusual transients to a conclusion." 90/

The standard is quite detailed in its requirements. For example, it specifies that the simulator shall be capable of reproducing a minimum of 75 abnormal and emergency conditions and specifically lists 22 conditions which must be included.

According to the Action Plan, simulator owners will be required to submit a report that indicates a plan for compliance with the regulatory guide which endorses ANS 3.5. Submittals from simulator owners will be reviewed and verified, through testing by the NRC, to assure that the simulators conform to the regulatory guide or provide acceptable alternatives. Verification of initial simulator conformance is planned to begin in FY82. 91/ In addition, ANS 3.5 specifies requirements for updating the capabilities of simulators

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89/ Ibid. p. I.A.4-5.

90/ American Nuclear Society. Nuclear Power Plant Simulators for use in Operator Training. [La Grange Park, Illinois, the Society], ANS 3.5, Draft revised March 1980. p. 4.

91/ NUREG-0660 op. cit. p. I.A.4-4.

and requires that the capabilities be reviewed annually by the licensee management. NRC reviews of updated simulator capabilities may be performed as part of the general audits of training programs discussed above.

In addition to specifying requirements for simulators to be used in training, the Action Plan stipulates that the NRC will perform research to improve the use of simulators in training operators, develop guidance on the need for operator action during accidents and gather data on operator performance. It is estimated that about $1.7 million will be spent on this research in the period from FY80 to FY82. 92/

92/ Ibid. p. I.A. 4-4.

PROCEDURES AT NUCLEAR POWERPLANTS

INTRODUCTION

Perhaps the most reasonable assessment of the NRC's past role in assuring adequate procedures for safe operation of a powerplant could be expressed in the words of the comic strip philosopher Pogo, who said, "We has met the enemy and they is us." The NRC had left to the licensee the task of developing and implementing procedures for plant operations. The agency's role in overseeing compliance by licensees was to spot check rather than to conduct substantive evaluations. This critical void can be attributed to the NRC's, and formerly the AEC's, philosophy of allocating to the operator those functions that did not involve hardware. The agency's policy was "defense-in-depth"—a focus on conservative design and operating margins and for redundancy of components and systems to compensate for the fact that no body of knowledge could ever be complete enough to reduce uncertainties and risks to zero. The assumption was that the system would be largely self-contained and that the operator therefore would be able to cope with problems. The NRC gave little attention to the human factors aspects of plant operations.

The accident at Three Mile Island revealed the fallacy of this assumption. The operator is critical to safe operations. Even the soundest technology can be misused and create a hazard. Left to itself, the TMI plant would have automatically shut down early in the incident. It was the operators' intervention and overriding of the safety systems which, while not the initial cause of the accident, contributed to and magnified it immensely. Both the President's Commission (1) and the NRC Special Inquiry Group (2) pointed out that human factors were weak links in nuclear power plant operations and that procedures, particularly emergency procedures, should be clear, concise, accurate, accessible and an aid in corrective action.

Procedures at Nuclear Powerplants

Procedures, together with control room design and operator training, are important human factors elements, intended to improve the performance of plant operators. Their purpose is to assist operators in controlling a nuclear power plant during normal and emergency conditions.

Operating procedures describe the operators' roles under normal conditions, the responsibilities of various plant personnel, and the routine use of machines and equipment, such as control board operation instructions and maintenance of power plant hardware systems, associated with operational tasks.

Emergency procedures provide techniques that assist operators in identifying, integrating and assessing scattered bits of information that arise under abnormal plant conditions so that they can take mitigating actions to minimize the possibility of plant damage and to ensure public safety.

In accordance with the requirements of 10 CFR 50, Appendix B, commercial nuclear power plants are to be operated as described in the operating and emergency procedures. TMI–2 had a total of 30 operating procedures, 25 emergency procedures and 15 plant abnormal procedures. (3) The accident involved events affecting a number of pieces of equipment and systems, as well as the plant overall, and called for application of 15 of the operating, emergency and abnormal procedures. (4)

Most of the 15 procedures were adequate for their intended purpose. A few, however, were found to be deficient either in that they caused confusion or did not specify correct actions, or they were plainly inadequate for their intended purpose. (5) Apparently, the operators were aware of some of the shortcomings and, as a result, neglected to adhere to the procedures strictly.

An example of a deficiency was that abnormal procedure 2203–2.2, which addresses turbine trips, while noting that the PORV will open on a turbine trip, does not include any precaution for ensuring that the valve shuts. Further, the operators are required to release some coolant following a turbine trip to prevent the water level in the pressurizer from exceeding 240 inches. They did so on March 28, 1979, contributing further to the ongoing loss of coolant.[1] (6)

Pressurizer system failures involving stuck-open PORVs or code safety valves are covered by two sections in Emergency Procedure 2202–1.5, but should have been placed in the Loss-of-Coolant Accident (LOCA) Procedure, 2202–1.3.

These types of flaws in the procedures have raised a number of questions with respect to the NRC's role in the future in this area. For example, what are the NRC's criteria for requirements in procedures? How does the Commission review them? How does it oversee licensee implementation? Since TMI, what improvements have been made to overcome the shortcomings?

Because of the relevance of procedures to safe operations of nuclear plants, the adequacy of the NRC's role in the past and its plans for the future deserve assessment.

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[1] For details, see the report of the Special Investigation, *Report to the United States Senate: Nuclear Accident and Recovery at Three Mile Island, A Special Investigation*, Subcommittee on Nuclear Regulation, Senate Committee on Environment and Public Works, June 1980.

PROCEDURES BEFORE THREE MILE ISLAND

Pursuant to 10 CFR 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants,"

> Every applicant for an operating license is required to include, in its final safety analysis report, information pertaining to the managerial and administrative controls to be used to assure safe operation.

"Quality assurance" is defined as comprising

> All those planned and systematic actions necessary to provide adequate confidence that a structure, systems or component will perform satisfactorily in service. Quality assurance includes quality control, which comprises those quality assurance actions related to the physical characteristics of a material, structure, component, or system which provide a means to control the quality of the material, structure, component or system to predetermined requirements.

Appendix B requires that the applicant/licensee establish and carry out a quality assurance program. To verify compliance with all aspects of the program and to determine its effectiveness, the NRC carries out periodic audits and inspections. In accordance with 10 CFR 50.70, the NRC has broad authority to inspect records, premises, activities and procedures of licensees and holders of Construction Permits.

In 1973, the AEC, wanting to emphasize to licensees the importance of quality assurance programs at operating nuclear power plants, held a series of conferences for licensee and NRC management in each of its five regional offices. The thrust of these conferences was to clarify the techniques used in routine inspections.

The following quotes on procedures are from handouts given to all licensees at the conferences: (7)

> The methods used in conducting an inspection include selective examination of records and procedures, observations of work performance, and discussions with personnel, including those individuals who have first-hand information at the working level.
>
> * * * * *
>
> [The NRC inspectors will] compare [licensee's] list of procedures against the listing of procedures that shall be developed in accordance with [licensee's] FSAR . . .
>
> Draft of procedures should be made available to Regulatory Operations personnel as early as practical. Procedures for . . . operating activities should be made available to [NRC] not less than 90 days prior to the scheduled fuel loading date . . .
>
> [NRC] would like to make two points clear regarding [its] review of procedures: First, [its] examination does not constitute approval of the procedures; secondly, [its] possession of copies of [licensee's] draft procedures should not impede [licensee's] revision review and refinements of these procedures.

The NRC's inspection program, the responsibility of the Office of Inspection and Enforcement, is conducted over the operating life of a plant. It is intended to verify that a licensee is complying with NRC requirements to ensure safe plant operations. Specific elements of the inspection program for operating reactors, conducted on a spot-check basis, (8) are:

> [R]eview of the basic systems and the procedures the licensee follows to ascertain that they conform with requirements, are technically sound, and are implemented properly.
>
> Analysis of the licensee's records of operation and interviews of personnel to confirm that actions called for by the prescribed systems and procedures are routinely followed.

These inspection mechanisms were in effect at the time of the Three Mile Island accident. (9)

The NRC's Office of Nuclear Reactor Regulation (NRR) was also responsible for procedures, but only with respect to their use in examinations for licensing of operators; it reviewed an applicant's program for developing and using the procedures in operator licensing examinations. NRR did not review in detail a licensee's actual procedures. (10)

Section 13.5, Plant Procedures, of NUREG–75–087, Standard Review Plan, Revision 1, describes the role of NRR's Operator Licensing Branch (OLB):

> OLB reviews the plant procedures, as described in the applicant's safety analysis report (SAR) . . . In general, it is not expected that detailed written procedures will be included in the SAR. The preliminary safety analysis report (PSAR) should describe preliminary schedules for their preparation, and the final safety analysis report (FSAR) should provide descriptions as to (their) nature and content. . . .

These informal reviews by the Operator Licensing Branch were supposed to ensure that plant procedures were incorporated accurately into the examinations for licensing operators by meeting the requirements of 10 CFR section 50.54 (i), (j), (k), (l) and (m), "Conditions of licensees." (11)

While the Licensing Branch may have provided some informal comments to the utilities during the course of its reviews, no formal evaluations were conducted, and the procedures were never formally docketed. (12)

In summary, prior to TMI, the Office of Inspection and Enforcement would review plant procedures on an audit basis, while the Operator

Licensing Branch reviewed them informally. Aside from this limited role, the NRC made no substantive inputs into procedures, not even under unique circumstances.

PROCEDURES SINCE TMI

TMI has presented the NRC with a rare opportunity to "atone for the sins of the past," and the agency has taken several actions relating to procedures. The Lessons Learned Task Force[2] recommended as a short-term action that guidance be provided to the licensee in implementing Regulatory Guide 1.33, "Quality Assurance Program Requirements (Operations)," specifically with respect to the procedure that addresses "Shift and Relief Turnover." The content of the procedure would require a shift turnover checklist to be completed and signed by oncoming and outgoing individuals responsible for operations in the control room. (13)

The Lessons Learned Task Force emphasized the necessity of sound emergency procedures based on "thorough engineering evaluation and realistic analyses of the dynamic response of the nuclear power plant." (14) The Task Force recognized that the past practices of the agency were insufficient in that they did not call specifically for an investigation of the compatibility of emergency procedures with the design of the systems involved. It recommended that reviews of procedures should also include consideration of experience outside the commercial nuclear industry with procedures for crisis investigation. (15)

Section I.C of the May 1980 draft of the NRC's TMI Action Plan contains short- and long-term actions for improving procedures, schedules for their implementation, the allocation of resources and reviews of the procedures by the Offices of Nuclear Reactor Regulation and Inspection and Enforcement. The objective is to:

> Improve the quality of procedures to provide greater assurance that operator and staff actions are technically correct, explicit and easily understood for normal, transient, and accident conditions. . . . (16)

With respect to the Short-Term Lessons Learned Task Force recommendations such as those on shift and relief turnover procedures, shift supervisor responsibilities and control room access, the Office of Nuclear Reactor Regulation issued written requirements to licensees and applicants for reviewing and revising the procedures. The Office of Inspection and Enforcement has not completed implementation of its plan. (17)

Programs are thus underway for the Lessons Learned Task Force recommendations. In most instances, the NRC has sent written requests that analyses be performed and detailed emergency operating procedures be prepared to implement the approved guidelines.

As the agency's audits and reviews are ongoing, an analysis of the results would be premature at this time. The Office of Nuclear Reactor Regulation is reviewing the lead operating plants; the Office of Inspection and Enforcement will conduct reviews of remaining plants. (18)

In the case of pilot monitoring of selected procedures for near-term Operating License applications,[3] an interdisciplinary and interoffice NRC task force will audit emergency procedures received from near-term operating licensees. The task force will conduct a thorough review of selected emergency procedures, focusing on sections that discuss symptoms and immediate actions. The work on each pending operating license application is scheduled to be completed prior to issuing a full power license to the applicant. (19)

The NRC is also undertaking a program, currently budgeted for development by July 1981, for upgrading procedures. It will be an expansion on and continuation of current efforts to improve the content, writing, format, review and monitoring of plant procedures and of their proper interrelationships. The Office of Nuclear Reactor Regulation will head this effort and will receive significant support from the Offices of Inspection and Enforcement, Standards Development, and Research. The plan will be coordinated with industry groups. (20)

In addition, the Probabilistic Analysis Staff of Nuclear Reactor Regulation is studying the feasibility, necessity and effectiveness of using interactive computer graphics to supply procedures, plant data and other useful information on request to assist control room operators. (21) In February 1980, an experimental cathode ray tube was installed in the Loss of Fluid Test Facility–2 (LOFT–2), a reactor being used for NRC safety research located at the Idaho National Engineering Laboratory in Idaho Falls, Idaho. The NRC is hoping to gain practical experience in optimizing the system's effectiveness as an operator aid in the control room. If feasible, the NRC may propose it as a backfitting requirement.[4] (22)

Thus, in the year since TMI, the NRC has acted to fill the void in its responsibilities for sound industry procedures and quality assurance programs at nuclear power plants. The results are not all in yet, but the program appears well-intentioned and comprehensive.

RECOMMENDATIONS

(1) The Senate Subcommittee on Nuclear Regulation should review periodically the NRC's substantive audits of procedures.

(2) The Subcommittee should require periodic updates on the feasibility of computer graphics displays on plant status and procedures in control rooms.

(3) Periodic substantive audits conducted by groups of experts from outside the commercial nuclear industry should be required.

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[2] An interdisciplinary team of engineers and scientists from various offices of the NRC, set up under the Office of Nuclear Reactor Regulation. Its purpose was to identify and evaluate safety concerns arising out of the TMI accident.

[3] A near-term Operating License application is one pending approval.

[4] A requirement that would apply to already licensed plants.

REFERENCES

1. The President's Commission on the Accident at Three Mile Island, *The Need for Change: The Legacy of TMI*, Final Report, October 1979, p. 53.

2. Nuclear Regulatory Commission Special Inquiry Group, *Three Mile Island: A Report to the Commissioners and to the Public*, NUREG/CR-1250, Volumes I and II, 1980, Volume II, Part II, pp. 596–597.

3. Ronald M. Eytchison, "Technical Assessment of Operating, Abnormal, and Emergency Procedures," Technical Staff Analysis Report to The President's Commission on the Accident at Three Mile Island, October 31, 1979, p. 5.

4. Ibid.

5. Ibid., pp. 3–5.

6. Metropolitan Edison Company, Interview of William Zewe, Metropolitan Edison Company, March 30, 1979, p. 3.

7. Statement of W. C. Seidle, "Regulatory Operations Panel Discussion at Regional Conferences on Quality Assurance for Operating Nuclear Power Plants," before the Regional Quality Assurance Conferences-Operations, November 26–29, 1973, pp. 3, 16–17.

8. J. C. LeDoux and C. Rehfuss, "The NRC Program of Inspection and Enforcement," *Nuclear Safety*, Volume 19, No. 6, November-December 1978, p. 677.

9. Letter from Norman C. Moseley, Office of Inspection and Enforcement, NRC, to Vivien Lee, TMI Special Investigation Staff, May 21, 1980.

10. Letter from Stephen H. Hanauer, Office of Nuclear Reactor Regulation, NRC, to Vivien Lee, TMI Special Investigation Staff, May 23, 1980, p. 1 (hereafter Hanauer Letter).

11. Ibid., NRC, Standard Review Plan, "Plant Procedures," Section 13.5, NUREG 75-087, Rev. 1, p. 13.5-1.

12. Op. cit., Hanauer Letter.

13. Office of Nuclear Reactor Regulation, "TMI-2 Lessons Learned Task Force Status Report and Short-Term Recommendations," NRC, NUREG-0578, July 1979, p. A-52.

14. Ibid., pp. 2–6.

15. Ibid.

16. Office of Nuclear Reactor Regulation, "NRC Action Plan Developed as a Result of the TMI-2 Accident," NRC, NUREG-0660, Volume 1, May 1980, p. I.C-1.

17. Ibid., pp. I.C-4—I.C-5.

18. Ibid., p. I.C-3.

19. Ibid., p. I.C-7.

20. Ibid., p. I.C-8.

21. Letter from Raymond DiSalvo, Office of Nuclear Regulatory Research, NRC, to Vivien Lee, TMI Special Investigation Staff, June 6, 1980.

22. Memorandum from Vivien Lee, TMI Special Investigation Staff, to the Human Factors Study Files, Re: "Cathode Ray Tube Displays in Reactor Control Room," June 13, 1980.

Chapter 4

Response of the Nuclear Regulatory Commission to Deficiencies Highlighted by the Three Mile Island Accident

By the

Comptroller General of the United States,
General Accounting Office

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-198829 May 27, 1980

The Honorable Gary W. Hart, Chairman
Subcommittee on Nuclear Regulation
Committee on Environment and
Public Works
United States Senate

Dear Senator Hart:

Subject: Do Nuclear Regulatory Commission Plans Adequately Address Regulatory Deficiencies Highlighted By The Three Mile Island Accident? (EMD-80-76)

On the morning of March 28, 1979, the Nation's worst commercial nuclear powerplant accident occurred at Three Mile Island in Pennsylvania. Starting with a minor malfunction in the nonnuclear part of the plant, a series of events occurred that severely damaged the nuclear core. Radioactive particles escaped from the damaged core and were pumped to an adjoining building where some radioactive gases were released to the environment. Although these releases were later determined to be small, the seriousness of the accident raised nationwide concern about the safety of nuclear power.

Within a matter of weeks, a number of groups began examining what happened and why. The President of the United States established a group to comprehensively study the accident, the Nuclear Regulatory Commission began a number of internal studies and created a special inquiry to independently review and report on the accident, the nuclear industry established the Nuclear Safety Analysis Center which performed an investigation, and the Congress held a number of hearings and established a special group to investigate the accident and examine its implications on the commercial future of nuclear power.

Inundated with numerous recommendations from these studies, the Commission drafted a plan to improve the regulation and operation of nuclear facilities. This plan, referred to as the Three Mile Island Action Plan, includes

(302546)

51 major tasks that the Commission believes are necessary to respond to the many Three Mile Island investigations and studies. These tasks are subdivided into about 177 specific actions, most of which have been prioritized and given a schedule for completion.

On February 1, 1980, you and Senator Simpson requested that we evaluate the Action Plan and the adequacy of the Commission's process for prioritizing and implementing the planned actions. To do this, we selected 10 major tasks for detailed review as agreed with your office. These tasks represent a cross section of the 51 tasks included in the Plan and include 49 actions already taken or proposed by the Commission (See Enclosure I for a listing of the 10 tasks.)

During the period of our review, the Plan was still in draft form and changed several times. The Commission was still adjusting the priorities of the tasks and the resources needed to carry them out. Completion of the Plan and approval by the Commissioners was not expected until May 1980. Although it was difficult to evaluate the specifics of the Plan under these circumstances, we have several observations about the process used by the Commission to create the Plan:

--The Commission has taken adequate steps to insure that all Three Mile Island recommendations were considered during the development of the Action Plan.

--The Commission's method of prioritizing the Action Plan tasks seems adequate and recognizes the need for quick action on safety-related problems.

--The Commission's actual or proposed efforts, to date, are adequately described in the Action Plan task descriptions.

--The Commission's estimated resources and time frames do not leave much margin for error.

--The Commission is relying heavily on the nuclear industry for the development of most corrective actions.

Because the successful and timely implementation of the Action Plan depends on many variables, we believe that means should be developed to keep track of the Commission's progress. The President has created a special group to oversee the Commission's actions over the next 2 years and we endorse this concept. We believe, however, that the Commission should also periodically report its progress to the Congress.

THE COMMISSION TOOK ADEQUATE CARE TO IDENTIFY AND CONSIDER THREE MILE ISLAND-RELATED RECOMMENDATIONS

The Commission took several actions to insure that all Three Mile Island-related recommendations were considered in developing the Action Plan. First, it created a special steering committee to develop a plan that recognized all the recommendations. This committee included individuals who had studied Three Mile Island events and were familiar with the issues and the findings of the various accident investigations.

Second, the Commission listed, at the end of each task described in the Action Plan, the Three Mile Island recommendations that either applied to or were used in developing the task. This shows the Commission's desire that the Action Plan adequately address the Three Mile Island recommendations. This does not mean, however, that the Commission intends to fully carry out every recommendation. The Commission staff did not believe that all recommendations can or should be fully implemented. Some recommendations are not completely applicable to the Commission, some are contradictory, and some may prove impractical or unnecessary as further analysis is performed. According to the Commission staff, however, each listed recommendation was considered in the development of the task and will be explored as the task is implemented.

Finally, the Action Plan identified--by major investigation--where all Three Mile Island-related recommendations are addressed in the Plan. For those recommendations that are not addressed, the Commission has given reasons for their exclusion. These exceptions will be approved by the Commissioners through their review and approval of the entire Action Plan.

The last action was motivated by our evaluation of an earlier Action Plan draft. By comparing the recommendations listed in the draft Action Plan to the major Three Mile

Island investigation reports, we identified a number of recommendations that the Commission had excluded. After bringing this to the Commission staff's attention, the staff renewed efforts to insure that all recommendations were considered and accounted for during the further development and implementation of the plan.

THE COMMISSION'S PRIORITY RANKING SYSTEM SEEMS ADEQUATE

The Commission's system for prioritizing the 177 actions, although not based on detailed analysis or criteria, seems adequate for its intended purpose. The priority system was similar to the one used by the Commission to rank generic safety issues. It was approved for use in the Action Plan by the Commissioners on December 21, 1979, and was subsequently found acceptable by the Advisory Committee on Reactor Safeguards and the Atomic Industrial Forum. It included the following six priority ranking factors.

	Points
1. Safety Significance of the Proposed Action	
High	100
Medium	50
Low	0
2. Type of Improvement	
Improves the human element	20
Fixes the hardware	10
3. Project is ongoing, the resources would be wasted if stopped	20
Project has not yet been initiated	10
4. Nuclear Regulatory Commission Resource Requirement	
Small (less than 2 staff-years)	20
Medium (between 2 and 10 staff-years)	10
Large (more than 10 staff-years)	0

5. Industry Resource Requirement: Total per nuclear unit over 40-year life--1 staff-year = $50,000

Small (less than 1 staff-year)..........	20
Large (more than 1 staff-year)..........	0

6. Timing of Improvement (i.e., how quickly will the expected benefit begin to be realized after initiation of task)

Short-term (within 1 year)..............	30
Near-term (within 2 years)..............	20
Long-term (within 3 years)..............	10
Extended beyond 3 years.................	0

The steps used to prioritize the Action Plan items include the following:

--Task managers, using their best judgment, ranked the action in terms of high, medium, or low safety significance.

--A technical group within the Action Plan steering committee, assigned priorities to each action using the six ranking factors and input from the task managers and the Commission operating offices.

--A meeting was held between the technical group and the task managers to discuss the priority of the actions and revisions made by the technical group.

--If there was disagreement between the technical group and the task manager, the differences were explained to the full steering committee with a majority vote deciding the priority ranking.

This system resulted in 55 actions being assigned a priority one, 46 items a priority two, and 29 items a priority three. In addition, 47 items were not assigned a priority because they were either normal, ongoing Commission functions or were items for which appropriate action had not yet been determined.

Generally, this system assigned a higher priority to those actions which not only are important to safety but also could be implemented quickly with the least Commission and industry resources. This, the Commission staff reasoned, would permit available resources to be used for as many actions as possible instead of being concentrated on a few costly and time-consuming items. Also, because the Commission thought that the human element in powerplant operations had been seriously neglected in the past, a higher priority was given to those actions as opposed to the ones that would improve hardware.

Although this process was based on the engineering judgment of the Commission's technical staff instead of a more precise risk-based analysis, we believe that it was adequate for its intended purpose. The Commission was not trying to rank these actions according to their relative safety importance. Instead, it was attempting to divide the large number of actions into safety categories as a way of assigning staff resources and dealing with as many of them as possible. At the completion of this process, the Commission selected 100 of the actions (out of about 177 in total) for some type of execution in the remainder of this fiscal year and the next. This included all priority one items, most priority two's, and some priority three's. Therefore, even though the priority ranking process was not as refined as it could have been, it is likely that the more important safety items are being addressed.

THE ACTION PLAN ADEQUATELY DESCRIBES COMMISSION ACTIONS

In our review of the 10 Action Plan tasks, we attempted to determine if the Commission was actually carrying out the tasks described in the Plan. Considering the draft status of the Plan, we found that it adequately described actions that the Commission either had already taken or had intended to take.

Included in the 177 actions are 67 which have already been approved by the Commissioners, with implementation either completed or firm dates scheduled for completion. These actions resulted primarily from special internal Commission studies done in the aftermath of Three Mile Island and were well described in the Action Plan.

The remainder of the Action Plan includes 110 actions that will be completed sometime in the future depending on their priority and the availability of Commission resources. Some have already been started, others are waiting on the completion and approval of the Action Plan, and others have been delayed pending separate consideration and action by the Commissioners. For these types of actions, we found that the Action Plan descriptions were less firm, but that individuals had been assigned to work on and be responsible for completing them in the time frame identified in the Plan. The Commission intends to initiate work on 33 of these actions during fiscal years 1980 and 1981. The remainder are deferred until fiscal year 1982 or later.

Most of these 110 actions reflect Three Mile Island-related recommendations which the Commission staff believes should be addressed. Many of them, however, require additional study before the staff can determine what action to take or even if the action is necessary considering its cost and relative importance to safety.

For instance, one such action is the "Nuclear Data Link" (Task III. A.3.4.). The Three Mile Island investigations found that the Commission headquarters personnel did not have adequate information to understand what was happening during the accident. Besides recommending that direct telephone lines be installed between operating plants and Commission headquarters, these investigations suggested that a system be installed to transmit plant operating data directly to the Commission's Incident Response Center in Bethesda, Maryland.

In response, the Commission inserted a task in the Action Plan to further study the cost and feasibility of this recommendation. A contract was awarded to a Department of Energy national laboratory to undertake the task and to recommend a course of action. Following the completion of this contract, the Commission will decide whether the recommendation should be implemented, discarded, or studied further. According to a Commission official, early indications are that the cost of the first proposal evaluated may be prohibitive and that less costly alternatives will have to be explored.

ACTION PLAN SCHEDULES AND RESOURCES--ARE THEY ADEQUATE?

The Commission went through several phases to estimate time frames and to identify the resources needed to implement each Action Plan item. We found that the Commission's overall process in this area was reasonable and should provide a good basis for planning the disposition of the Action Plan tasks. Whether the tasks can be completed on time with the estimated resources, however, can only be determined as the Plan is implemented.

The Action Plan includes estimated time frames and resources needed for most of the Action Plan items. These estimates, for the most part, were prepared by the five major Commission offices depending upon the priority assigned to the Action, the perceived role of the Office in completing the task, and the resources available. Because the Commission budget cycle has already been completed for fiscal years 1980 and 1981, it was necessary for each Office to reassign both people and money from programmed activities to the Action Plan tasks.

In doing this, each office identified the resources that could be spared without seriously affecting its overall regulatory and licensing mission. These resources were spread over as many of the applicable actions as the offices reasonably thought they had time to implement. The Action Plan steering committee and the Commission's Office of the Controller reviewed the justification for the resources assigned to each action, were instrumental in adjusting them as necessary, and generally determined that they were adequate to carry out the task. Although we have no basis to disagree, we believe that the resources assigned to the actions do not leave much margin for error. They appeared to be the minimum that the Commission could assign and still be able to do the task.

This was confirmed by several Commission officials who characterized the resources in the plan as austere. One official, in particular, noted that the Plan--as well as other Commission activities--did not leave much room for maneuvering. If another major accident were to occur, if unforeseen licensing problems were to develop, or if supplemental and regular appropriation bills are not passed as requested, this official said that personnel assignments and office priorities will have to be reassessed, including those in the Action Plan. He did not think it inappropriate, however, for a planning document to fully account for all staff time and resources or attempt to get as much out of those resources as possible.

We agree with this position and believe that the Commission has gone through a reasonable process for estimating schedules and assigning resources to the Action Plan tasks.

Whether the schedules and resources for the individual actions are adequate, however, can only be determined as the Plan is implemented.

THE COMMISSION HAS INCREASED RELIANCE ON THE INDUSTRY

The only way that the Commission can implement the large number of Action Plan items during the remainder of this year and the next is to rely heavily on the nuclear industry to study the items and to develop and implement the corrective actions. For the most part, the Commission has only scheduled minimal time, as described in the previous section, to develop general criteria and to review the implementation efforts of the industry.

As a result, the successful completion of the Action Plan depends primarily on how seriously the industry addresses the action items and their attitude toward doing a quality job. This could, however, vary significantly throughout the utility and nuclear industry. For instance, one of the Action Plan items required utility companies--with plants close to receiving an operating license--to perform a partial control room design review. This was done because several Three Mile Island investigations considered present-day control rooms inadequate for operators to understand and control a reactor during accident conditions.

The Commission, however, did not develop criteria or guidelines for these utilities to follow, leaving each one to decide what and how much to do. 1/ As a result, of the two reports received and examined by the Commission thus far, the utility with a relatively good control room design did what the Commission believes is a good review, while the one with a relatively poor design did a bad review. Because of this problem, the Commission has decided to redo the control room reviews for each of these utilities, using a contractor specially qualified in assessing the relationships between man and machine.

1/According to Commission officials, control room design and review criteria will be developed later this summer. At that time all utilities with plants in operation or under construction will be required to perform a complete control room design review.

CONCLUSIONS AND RECOMMENDATIONS

Through the Action Plan, the Commission is implementing a massive program to upgrade safety at nuclear powerplants. The planned actions seem appropriate for this purpose, but because the program is in its infancy, success or failure cannot be determined at this time.

We believe that the Commission is stretching its resources very thin and placing major dependency on industry and other organizations. Also, budget rescissions, another major accident, or future Commission mandated responsibilities could have a major impact on successful completion of the program. We therefore believe that some oversight mechanism should be established to provide the Congress and the public with periodic information on the status of each action and how well the Commission is implementing its plan.

In this respect, President Carter, on March 18, 1980, created a "Nuclear Safety Oversight Committee" to oversee the Commission's activities and assess the progress being made to implement the recommendations of the President's Commission on the Accident at Three Mile Island. Consisting of five members from outside the Federal Government, this committee will have its own technical staff and appropriations and, according to an administration official, is expected to be in existence for 2 years.

We endorse this concept and believe that such independent oversight of the Commission is needed to insure compliance with important Three Mile Island recommendations and to guarantee that progress is made toward improving reactor safety. To assess the Commission's progress in implementing the Action Plan, however, we also believe that the Commission should report periodically to the Congress on the status of the Plan. This report should specifically describe the progress and resources spent on each action item as compared to the original Plan.

In addition, because the Commission has depended greatly on the nuclear industry to review and implement Three Mile Island recommendations, we believe that the new "Nuclear Safety Oversight Committee" should pay particular attention to how well the industry responds. If the response, in the Committee's opinion, is not adequate, the Commission should be required to reevaluate its role in seeing that the Action Plan tasks are properly implemented.

RECOMMENDATION TO THE COMMISSION

We recommend that the Commission periodically report to Congress on its progress in implementing the Action Plan, specifically providing the status of each action compared to the original Plan. If the Commission does not agree with the recommendation, congressional oversight committees should consider formally requesting periodic reports pursuant to our recommendation.

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As requested by your office, we did not obtain official Commission comments. In addition, we will restrict the distribution of the report until July 30, 1980, when your subcommittee's report on Three Mile Island is expected to be published. At this time, we will send copies of this report to the Commission and other interested parties.

Sincerely yours,

Elmer B. Staats

Comptroller General
of the United States

THREE MILE ISLAND ACTION PLAN TASKS WE REVIEWED

To test the accuracy of the Three Mile Island Action Plan, we reviewed the following 10 tasks. They represent a cross-section of the 51 tasks in the Action Plan and include 49 specific actions already taken or proposed by the Nuclear Regulatory Commission.

1. Improve the training and qualifications of nuclear powerplant operating personnel (Task I.A.2.).

2. Insure that the results of equipment failures, operating errors, or other powerplant problems are properly reported, analyzed, and distributed to the people that need to take corrective action (Task I.E.).

3. Improve control room designs so plant operators will be better able to understand and respond to emergencies. (Task I.D.).

4. Require utilities to install additional powerplant features that will control an accident or limit the radiological releases during the accident (Task II.B.).

5. Require that certain plant instruments be capable of monitoring and surviving accident conditions (Task II.F.).

6. Improve the capability of utilities to respond to radiological emergencies (Task III.A.I.).

7. Improve the Commission's emergency preparations and ability to respond to accidents (Task III.A.3.).

8. Improve public protection following an accident by upgrading radiation monitoring equipment and methods of collecting and analyzing radiation data (Task II.D.2.).

9. Strengthen the Commission's authority to penalize utilities that do not conform to regulatory requirements (Task IV.A.).

10. Establish a Commission policy on safety (i.e., what level of nuclear regulation is enough) (Task V.1.).

RECOMMENDATIONS MADE BY VARIOUS GROUPS WHICH ARE NOT REFERENCED TO A TASK IN NRC'S MARCH 5, 1980, THREE MILE ISLAND ACTION PLAN

This document includes Three Mile Island (TMI) recommendations which NRC did not include (by specific reference) in its March 5, 1980, draft TMI Action Plan. After giving this list to NRC, the Agency started new efforts to insure that all TMI recommendations were either referenced to specific tasks in the Action Plan or provided reasons for their exclusion. Specifically, NRC added a second volume to the Action Plan which lists all TMI recommendations (by major investigation report) and identifies the Action Plan tasks to which they apply.

Annotated to the left of the recommendation is a code which explains NRC's disposition of these recommendations in accordance with the second volume of the Action Plan.

(a) NRC considered the recommendation adequately covered by an existing Action Plan task and included a reference to the recommendation at the end of the task description.

(b) NRC determined that the recommendation relates, in some way, to an existing Action Plan task and has directed the staff to consider it as the task is implemented. The recommendation is not always included as a reference at the end of the applicable task description.

(c) NRC disagrees with this recommendation or believes that the recommendation is beyond NRC's purview. There is no Action Plan task that relates to this recommendation.

(d) NRC believes that this recommendation is covered under existing policies, practices, and procedures and will be taken into consideration in ongoing work. There is no Action Plan task that relates to this recommendation.

RECOMMENDATIONS MADE BY VARIOUS GROUPS WHICH ARE NOT REFERENCED TO A TASK IN NRC'S MARCH 5, 1980, THREE MILE ISLAND ACTION PLAN

I. Operational Safety

President's Commission Report

(a) 1. To the extent that the industrial institutions we have examined are representative of the nuclear industry, the nuclear industry must dramatically change its attitudes toward safety and regulations. The Commission has recommended that the new regulatory agency prescribe strict standards. At the same time, the Commission recognized that merely meeting the requirements of a government regulation does not guarantee safety. Therefore, the industry must also set and police its own standards of excellence to ensure the effective management and safe operation of nuclear power plants. (B1)

(a) 2. The wording of procedures must be clear and concise. (B5a)

(a) 3. The content of procedures must reflect both engineering thinking and operating practicalities. (B5b)

(a) 4. The format of procedures, particularly those that deal with abnormal conditions and emergencies, must be especially clear, including clear diagnostic instructions for identifying the particular abnormal conditions confronting the operators. (B5c)

(b) 5. These institutions could be national, regional, or specific to individual nuclear steam systems. (C1a)

(b) 6. Reactor operators should be required to graduate from an accredited training institutions. Exemption should be made only in cases where there is clear, documentary evidence that the candidate already has the equivalent training. (C1b)

(b) 7. The training institutions should be subject to periodic review and reaccreditation by the restructured NRC. (C1c)

(b) 8. Candidates for the training institute must meet entrance requirements geared to the curriculum. (C1d)

(a) 9. Comprehensive ongoing training must be given on a regular basis to maintain operators' level of knowledge. (C3a)

(a) 10. Such training must be continuously integrated with operating experience. (C3b)

TMI-2 Lessons Learned Task Force
Status Report and Short-Term
Recommendations (NUREG-0578)

(b) 1. Require that the Technical Specifications for each reactor provide that the reactor be placed in a hot shutdown condition within 8 hours and in a cold shutdown condition by the licensee within 24 hours of any time that it is found to be or have been in operation with a complete loss of safety function (e.g., loss of emergency feedwater, high-pressure ECCS, low-pressure ECCS, containment, emergency power or other prescribed safety function). Require that an assessment of the cause of the loss of safety function be made (e.g., maintenance, operations error) and that an evaluation of alternative corrective actions be made and documented by the licensee. Require that the senior corporate officer responsible for operation of the facility present the licensee's recommendation for corrective action and evaluation of the alternatives at a public meeting with senior NRC officials. Require that the senior NRC officials issue their decision at that public meeting, or a subsequent public meeting if time is required for staff evaluation, concerning the adequacy of the changes to improve operational reliability proposed by the utility. Allow the facility to return to power only after NRC approval of the changes proposed by the licensee. (2.2.3)

TMI-2 Lessons Learned Task Force
Final Report Recommendations
(NUREG-0585)

(b) 1. As part of the training program for all licensed operators, a one-week course should be conducted by the NRR operator licensing program personnel with assistance from other NRR technical personnel. Particulars of the course would include:

(a) Safety analyses

(b) Probabilistic assessments

(c) Current safety issues and recent significant operating experience

(d) NRC and industry responsibilities for safety

This recommendation would reinforce the knowledge of a respect for accident/transient sequences as well as providing a positive feedback for better decisions by NRC staff on reactor operations and design matters. Additional NRC staffing will be required to accomplish this objective. [1.4.(3)]

(a) 2. The NRR operator licensing program personnel should sponsor an annual workshop for licensed operators to be attended by at least one representative of the licensed shift personnel at each unit. The purpose of the workshop is to provide an opportunity for exchange of information on operating experiences between the NRC staff and the utility shift personnel. For example, such a seminar could lead to an exchange of information on (a) NRC safety concerns related to shift operations, (b) the impact of licensing on shift activities and personnel, and (c) recommendations from shift personnel concerning changes in reactor regulation that would improve safety. [1.4.(5)]

(a) 3. As a less prescriptive alternative to Recommendation 6 of SECY 79-330E that "Phase II, III, and IV cold training program instructors and all hot training program instructors that provide instruction in nuclear power plant operations hold senior operator licenses and be required to successfully participate in applicable requalification programs to maintain their instructor status," the following is considered acceptable: Such instructors should hold or have previously held a senior reactor operator (SRO) license on a comparable nulcear power plant and currently possess instructor certification from the Institute of Nuclear Power Operations, provided the INPO certification program has been examined and found acceptable to the NRC. Emphasis should be placed on an instructor's ability to instruct, in addition to his technical competence. [1.4.(6)]

(b) 4. At the present time, several groups are addressing the subject of qualifications of personnel somewhat independently of one another. Even though each of the efforts is appropriate on a short-term basis, a coordinated approach must be developed for the long term. The NRC should increase the staff resources in this area, assure the hiring of needed professional disciplines to increase present staff capabilities, and designate responsibilities and organizational entities within the various offices. (1.5)

(a) 5. Shift Supervisor (person in charge of operations on shift at the station)-Shift Supervisors should have at least a Bachelor of Science degree or equivalent training and experience in engineering or the related physical sciences. The Shift Supervisor should also hold a senior reactor operators license (issued under new proposed requirements defined below) and have served as a reactor operator for one year or senior reactor operator for six months. In establishing equivalency with a Bachelor of Science degree, consideration should be given not only to formal courses in engineering and related sciences, but also to education in the liberal arts. It is recommended that the use of the equivalency to a Bachelor of Science degree be exercised to only a limited degree and that most shift supervisors hold degrees. It is also recommended that shift supervisor qualifications include leadership training and experience. [1.6(1)]

(a) 6. Senior Reactor Operator (e.g., shift foreman in a multi-unit station)-Senior Reactor Operators should have at least the same general technical education and specific training in transient and accident response characteristics of nulcear power plants as recently articulated for the shift technical advisor. Additional recommendations for upgrading senior reactor operator qualifications are identified in the Commission Paper SECY 79-330E on Qualification of Reactor Operators. [1.6(2)]

(a) 7. At present, a basic fundamentals course of approximately twelve weeks is required as part of the operator training program. A prerequisite to satisfactory performance of nculear power operation is the fundamental understanding of nuclear technology. The Task Force believes twelve weeks to be insufficient time to provide a broad and comprehensive level of understanding in the fundamentals of nuclear technology. It is recommended that the NRC, perhaps in consultation with INPO, examine the content of the basic fundamentals course and establish definitive instructional requirements for the course. [1.6(3)]

Report of Special Review Group,
Office of Inspection and Enforcement,
NRC (NUREG-0616)

(d) 1. A survey of all operating plants should be conducted to determine the effectiveness of maintenance programs. As a minimum the survey should identify:

a. Maintenance staffing characteristics such as number per shift, types of skills, and training of the staff.

b. Maintenance practices such as what types of maintenance can be performed on back shifts, the number of technicians involved, relationship to QA/QC, spare parts philosophy and inventory, and preventative maintenance.

c. Change management related to jumpers, temporary modifications, bypass, out-of-service equipment and others.

The survey results should provide IE with adequate information to assess the adequacy of current licensee practices and to identify necessary changes. (2.5.3.1)

(a) 2. Evaluate the need for more comprehensive reporting requirements with attention on failure analysis of failed equipment. This should be considered in relation to Licensee Event Report (LER) evaluation and the Nuclear Plant Reliability Data System (NPRDS) interface. (Section 2.7) (2.5.3.2)

(a) 3. The SRG feels that requiring implementation of a preventative maintenance program at licensed facilities should be studied to determine if such a requirement should be universally imposed. (2.5.3.3)

(d) 4. The IE inspection program should require and verify that the maintenance program be in effect and adequately staffed prior to operation of the plant. (2.5.3.4)

(d) 5. Develop guidance for the resident inspector to relay for further NRC analysis information about events not reported by the licensee. (2.7.1)

(a) 6. NRR should revise facility technical specifications for all single unit facilities (or multi-unit facilities with separate unit control rooms) to require the presence of two licensed operators in the control room at all times when the reactor is in Modes 1, 2, or 3. (3.13.12.1)

(a) 7. NRR should evaluate multi-unit facility technical specifications to determine if additional control room operator requirements during operation in Modes 1, 2, or 3 are appropriate for facilities with shared (common) control rooms for the multiple units. (e.13.12.2)

(a) 8. NRR should evaluate the need for requiring the shift supervisor (or an assistant shift supervisor) to remain in the control room area at all times when the reactor is in Modes 1, 2, or 3. (3.13.12.3)

Three Mile Island-A Report to the Commissioners and to the Public (Rogovin)

(b) 1. One or more data centers should be established by the industry, manned 24-hours a day by nuclear experts, to which essential plant parameters would be telemetered automatically (p. 107).

(b) 2. The Office of Analysis and Evaluation of Operational Data (AEOD) should be given tha task of developing recommendations as to where actions to meet operating problems ought to be required. These recommendations should, in each instance, be required to be rejected, modified, or imposed by the appropriate program office of the NRC within a fixed period of time. Unresolved disagreements between AEOD and a program office could be required to be reviewed by the Commission or Administrator (p. 99).

(b) 3. AEOD should be staffed in part on a rotational basis from all the other offices and branches at a level of no less than 35-40 professionals (p.99).

(b) 4. More emphasis should be given to supplementing the resident inspector with a team or blitz approach in which a group of inspectors make unannounced visits to condict in-depth inspections of the overall operation of a plant (p. 100).

(a) 5. More attention should be given to reactive inspections (responding to notifications, complaints, specific problems, or following up on previous difficulties) (p. 100).

(b) 6. More effort should be devoted by regional offices to evaluating each utility across the board and vis-a-vis other utilities in order to identify weak spots and problem areas. If the operation is not judged to be satisfactory, then the reactor should be required to be shut down (p. 100).

(b) 7. The NRC should assume a direct role in the training of operators including certification of training facilities, establishment of a minimum curriculum, and certification of instructors (p.105).

II. Siting and Design

President's Commission Report

(a) 1. The NRC or its successor should, on a case-by-case basis, before issuing a new construction permit or operating license assess the need to introduce new safety improvements recommended in this report, and in NRC and industry studies. (A8a)

(a) 2. The commission recommends that continuing in-depth studies should be initiated on the probabilities and consequences. These studies should include a variety of small-break loss-of-coolant accidents and multiple-failure accidents, with particular attention to human failures. (D4a)

(a) Such studies should be conducted by the industry and other qualified organizations and may be sponsored by the restructured NRC and other federal agencies.(D4d)

TMI-2 Lessons Learned Task Force Status Report and Short-Term Recommendations (NUREG-0578)

(a) 1. Evaluation of the containment isolation experience at TMI-2 shows that design features at some other plants may be inadequate in three respects. First, the lack of diverse actuation signals was a contributing factor at TMI-2 in not isolating the containment until after a significant quantity of water had been pumped from the containment sump into the auxiliary building. This is a significant deficiency in some of the older designs and should be corrected. Second, the sequence of events at TMI-2 illustrated the need for careful reconsideration of the isolation provisions of non-essential systems inside containment. Reconsideration should include the identification of those systems that can be isolated indefinitely and those systems that should be selectively isolated only after it is established that they are not essential to continued core cooling or performance of engineered safety features. Third, the experience gained at TMI-2 indicates that the resetting of the containment isolation signal in some designs may result in automatic reopening of some containment isolation valves. Licensees should review their designs and correct this design error if it is found. (2.1.4)

TMI-2 Lessons Learned Task Force
Final Report Recommendation (NUREG-0585)

(None)

Report of Special Review Group,
Office of Inspection and Enforcement,
NRC (NUREG-0616)

(None)

Three Mile Island- A Report to
the Commissioners and to the
Public (Rogovin)

(None)

III. Emergency Preparedness and Radiation Effects

President's Commission Report

(c) 1. The Commission recommends the establishment of expanded and better coordinated health-related radiation effects research. This research should include, but not be limited to:

(1) biological effects of low levels of ionizing radiation;

(2) acceptable levels of exposure to ionizing radiation for the general population and for workers;

(3) development of approaches to mitigate adverse health effects of exposure to ionizing radiation; and

(4) genetic or environmental factors that predispose individuals to increased susceptibility to adverse effects.

This effort should be coordinated under the National Institutes of Health -- with an interagency committee of relevant federal agencies to establish the agenda for research efforts -- including the commitment of a portion of the research budget to meet the specific needs of the restructured NRC. (E1a,b,d,e)

(a) 2. To ensure the best available review of radiation-related health issues, including reactor siting issues, policy statements or regulations in that area of the restructured NRC should be subject to mandatory review and comment by the Secretary of the Department of Health and Human Services. A time limit for the review should be established to assure such review is performed in an expeditious manner. (E2)

(b) 3. The commission recommends, as a state and local responsibility, an increased program for educating health professionals and emergency response personnel in the vicinity of nuclear power plants. (E-3)

(a) 4. Plans for protecting the public in the event of off-site radiation releases should be based on technical assessment of various classes of accidents that can take place at a given plant. (F2)

(a) 5. Plans should exist for protecting the public at radiation levels lower than those currently used in NRC-prescribed plans. (F2c)

(a) 6. All local communities should have funds and technical support adequate for preparing the kinds of plans described above. (F2d)

(c) 7. Research should be expanded on medical means of protecting the public against various levels and types of radiation. This research should include exploration of appropriate medications that can protect against or counteract radiation. (F3)

(b) 8. Commission studies suggest that decision-makers may have overestimated the human costs, in injury and loss of life, in many mass evacuation situations. The Commission recommends study into the human costs of radiation-related mass evacuation and the extend, if any, to which the risks in radiation-related evacuations differ from other types of evacuations. Such studies should take into account the effects of improving emergency planning, public awareness of such planning, and costs involved in mass evacuations. (F5)

(a) 9. Since the utility must be responsible for the management of the accident, it should also be primarily responsible for providing information on the status of the plant to the news media and to the public;

but the restructured NRC should also play a supporting role and be available to provide background information and technical briefings. (G1a)

(c) 10. Since the state government is responsible for decisions concerning protective actions, including evacuations, a designated state agency should be charged with issuing all information on this subject. This agency is also charged with the development of and dissemination of accurate and timely information on off-site radiation doses resulting from releases of radioactivity. This information should be derived from appropriate sources. (See recommendation F.1.) This agency should also set up the machinery to keep local officials fully informed of developments and to coordinate briefings to discuss any federal involvement in evacuation matters. (G1b)

(a) 11. Those who brief the news media must have direct access to informed sources of information. (G2a)

(a) 12. Technical liaison people should be designated to inform the briefers and to serve as a resource for the news media. (G2b)

(b) 13. The primary official news sources should have plans for the prompt establishment of press centers reasonably close to the site. These must be properly equipped, have appropriate visual aids and reference materials, and be staffed with individuals who are knowledgeable in dealing with the news media. These press centers must be operational promptly upon the declaration of a general emergency or its equivalent. (G2c)

(c) 14. All major media outlets (wire services, broadcast networks, news magazines, and metropolitan daily newspapers) hire and train specialists who have more than a passing familiarity with reactors and the language of radiation. All other news media, regardless of their size, located near nuclear power plants should attempt to acquire similar knowledge or make plans to secure it during an emergency. (G3a)

(c) 15. Reporters discipline themselves to place complex information in a context that is understandable to the public and that allows members of the public to make decisions regarding their health and safety. (G3b)

(c) 16. Reporters educate themselves to understand the pitfalls in interpreting answers to "what if" questions. Those covering an accident should have the ability to understand uncertainties expressed by sources of information and probabilities assigned to various possible dangers. (G3c)

TMI-2 Lessons Learned Task Force Status Report and Short-Term Recommendations (NUREG-0578)

(None)

TMI-2 Lessons Learned Task Force Final Report Recommendations (NUREG-0585)

(None)

Report of the Special Review Group, Office of Inspection and Enforcement, NRC (NUREG-0616)

(b) 1. Expand training for IE supervisors and management to ensure that fundamentals in various disciplines and licensee operations are retained in order to ensure that supervision/management is prepared to direct NRC emergency activities. The following training is recommended:

--RONS Section Chiefs and Branch Chiefs should attend a 1-week BWR/PWR refresher every two years.

--RONS Section Chiefs and Branch Chiefs should attend a 1-week refresher in health physics, security, and emergency planning every three years.

--Health physics and security supervisors should attend a 1-week BWR/PWR, fuel facility, and test/research reactor refresher every two years.

--Regional Director and IE Division Director should attend a refresher on BWR/PWR operations, health physics, and emergency planning every three years. (3.7.2.4)

(b) 2. Review training needs for IE staff not directly involved in operating reactors to ensure staff readiness for emergencies. Several suggested training courses are:

--DOE investigator course

--MORT training

--Radiological emergency response operations (DOE)

--Specific training regarding transportation accidents or fuel/materials facilities.

--Headquarters staff refresher on BWR/PWR operations, health physics, and emergency planning.

--Construction inspector training concerning emergency response. (3.7.2.5)

(b) 3. Consider offering training in emergency response to appropriate State and local agencies. (3.7.2.6)

(b) 4. Conduct emergency response training, as necessary, for other Offices and Divisions within NRC. (3.7.2.7)

(a) 5. Establish an emergency response training program involving all levels of NRC employees. Periodically brief the NRC Commissioners, EMT members, and IRACT members concerning emergency preparedness. (3.7.3.1)

(d) 6. Ensure that licensee administrative controls do not intentionally delay or unnecessarily hamper IE personnel. (3.8.1.1)

(b) 7. Establish and document policy regarding all administrative matters affecting IE's ability to function effectively and efficiently in response to an emergency. Provide services and supplies as necessary. (3.8.2.1)

(a) 8. The licensee's meteorological system should be supplied with dedicated power or backup emergency power. The windspeed indicators should be upgraded to allow measuring the highest expected wind speed. (3.9.1.2)

(a) 9. Expedite installation of the second dedicated telephone line to each major facility. Both dedicated telephone lines should contain sufficient flexibility to accommodate additional tie-ins, such as from an offsite "command center" or trailer complex. (3.11.2.1)

(a) 10. Consider backup communication links to enhance reliability in the case of a Centrex interruption. For example, a radiotelephone link to the licensee's microwave communication system may be appropriate. (3.11.2.2)

(d) 11. Establish contractual arrangements with telephone companies serving major facilities to ensure swift installation of telephone facilities necessary to support extensive communications following an accident. (3.11.2.3)

(a) 12. Establish Inspection and Enforcement as the lead Office for coordinating and implementing the IRP revision. (3.14.1.2)

(a) 13. Establish the Director of Inspection and Enforcement, or alternate, as the Deputy Director of EMT. (3.14.1.3)

(a) 14. Designate an individual as IE Headquarters Emergency Officer to coordinate emergency response planning. 3.14.1.4)

(b) 15. Require all Part 50 and Part 70 licensees to assess their security organization's structure, amnning, and training, from the viewpoint of ability to respond to major accidents. The review should also consider agreements with outside support agencies. (3.15.1)

(b) 16. Request NMSS to review licensee security contingency plans presently under consideration to ensure that security's functions under emergency conditions are properly defined. Areas of consideration should include emergency organization, personnel processing, searches, and patrols. (3.15.2)

(b) 17. Require licensees to establish conpensatory search plans and procedures for use following the loss of normal facilities. (3.15.3.1)

(b) 18. Require all Part 50 and Part 70 licensees to review their current badging system and establish procedures for processing and identifying response personnel in all categories. Licensees should consider an offsite location or staging area with an individual responsible for coordinating the processing operation. (3.15.3.2)

(b) 19. Require contractors, vendors, State agencies, and Federal agencies that would be involved in a site response to furnish licensees with current lists of authorized individuals who would normally respond. (3.15.3.3)

(d) 20. Using inspection teams comprising regional RONS, FFMS, and Safeguards inspectors and Headquarters Safeguards personnel, inspect in detail the access control systems of every licensee required to comply with Part 73.55. Determine whether such systems unacceptably affect the licensee's ability to control or mitigate an accident. (3,15.4)

(b) 21. Train safeguards inspectors in emergency response techniques, including radiation protection. The Emergency Response Operations Course conducted by DOE in Nevada might partially accomplish such training. (3.15.5.1)

(d) 22. Provide vehicles equipped for extended trips, hazardous weather conditions, and emergency response. (3,15,5.2)

(d) 23. Furnish vehicles with both inter-vehicle and field communication equipment and with secure radio communication with NRC Operations Center. (3.15.5.3

(d) 24. Revise the security and emergency planning modules to include full examination of the security organization's responsibilities and capabilities during emergency conditions. Specific areas to be examined should include the security organization structure, personnel processing, site access control, outside assistance, and radiation protection. The module should also examine security personnel training programs in the above areas. (3.15.6)

(d) 25. Be prepared to direct existing resident inspectors to assist in accident response or special post-accident insepction/investigation functions. Residents from a similar facility would be valuable response team members. Whenever possible, residents should be utilized such that a site is not left without a resident. (3,16.3)

Three Mile Island-A Report to the Commissioners and to the Public (Rogovin)

(c) 1. At reactor sites, the radiation protection function should be made independent of operations and be elevated to equal importance (p.155).

(b) 2. In establishing specific emergency planning distance, probably maximum radiation doses from various projected accidents at different distances from a plant should be carried forward by the Commission into specific cirteria that incorporate maximum dose levels, probability factors, and associated time limits (p.133).

(b) 3. Any decision by NRC headquarters to recommend evacuation should be made by the director of the EMT and thereafter should be communicated to the State authorities by the highest official of the NRC avialable (p.134).

(b) 4. FEMA and other federal agancies involved should have senior representatives present at the NRC's Incident Response Center (p.134).

(b) 5. The NRC emergency response plans should be revised to shift the management of the NRC's overall response to the site as quickly as possible (p.135).

(b) 6. NRC must not be constrained by its own attitudes to take a passive role during an accident, if circumstances demand more direct intervention. If NRC's regulations should make clear the authority to demand information, and in the extreme case to impose its own decisions on a licensee (p.34). However, the senior NRC official at the site and his technical team should not be authorized to assume command of the plant (p.135-136).

(b) 8. EPA should be assigned long-term radiological monitoring responsibilities after an accident, and HEW should be given the lead responsibility for population does assessments and calculation of health impacts.(p.137).

(b) 9. The emergency plan should not be just an abstract document. It should make realistic provisions for such seasonal or other variations as snow storms and large summer populations; and it should provide that the plant may have to be shut down, if the plan becomes inoperable for more than a short period ot time (p.132).

(b) 10. A senior NRC official should be the principal spokesman at onsite or near-site press conferences during an accident at a nuclear power plant. A utility spokesman should be present at such press conferences to provide simultaneously any differing views or additional information the utility feels is necessary to keep the public fully informed (p.157)

(b) 11. As appropriate, a State official should also be present at these press conferences and should have sole jurisdiction for public information concerning evaluation and related emergency planning (p.157).

(b) 12. The utility should maintain responsibility for initial public statements until the NRC estimates an onsite or near-site capability. Press briefings should be held three times a day, or more frequently if dictated by the situation (p. 157).

IV. Practices and Procedures

President's Commission Report

(a) 1. Duplicative consideration of issues in several stages of one plant's licensing should, wherever possible, be reduced by allocating particular issues (such as the need for power) to a single stage of the proceedings. (A10a)

(a) 2. Issues that recur in many licensings should be resolved by rulemaking. (A10b)

(a) 3. The agency should be authorized to conduct a combined construction permit and operating license hearing whenever plans can be made sufficiently complete at the construction permit stage (A10c)

(b) 4. There should be provision for the initial adjudication of license applications and for appeal to a board whose decisions would not be subject to further appeal to the administrator. Both initial adjudicators and appeal boards should have a clear mandate to pursue any safety issue, whether or not it is raised by a party. (A10d)

(a) 5. An Office of Hearing Counsel should be established in the agency. This office would not engage in the informal negotiations between other staff and applicants that typically precede formal hearings on construction permits. Instead, it would participate in the formal hearings as an objective party, seeking to assure that vital safety issues are addressed and resolved. The office should report directly to the administrator and should be empowered to appeal any adverse licensing board determination to the appeal board. (A10e)

(a) 6. Any specific safety issue left open in licensing proceedings should be resolved by a deadline. (A10f)

(a) 7. Require the agency to set deadlines for resolving generic safety issues. (A9b)

TMI-2 Lessons Learned Task Force Status Report and Short-Term Recommendations (NUREG-0585)

(None)

TMI-2 Lessons Learned Task Force Final Report (NUREG-0585)

(a) 1. As part of the inspector training program of the Office of Inspection and Enforcement (IE), operator licensing program personnel of the Office of Nuclear Reactor Regulation and should (a) provide information to IE inspectors on the operator licensing program and (b) identify the types of information the IE inspectors should provide to assist NRR in making decisions with regard to the renewal of operator licenses. (1.4.1)

(b) 2. The approach, methods, and organization of the NRC staff in performing licensing reviews of nuclear power plants should be revised to emphasize the following objectives: (12)

(1) An overall system level, integrated review that gives full consideration to operational safety aspects and provides for a design basis accident assessment function from event initiation through consequence mitigation, including the review of emergency operating procedures.

(2) Timely analysis of operating experience and implementation of needed changes derived from operating experience.

(3) Discipline in the application of a single overall safety goal.

(4) Continuity of licensing cognizance and responsibility from initial plant licensing, throughout construction and into operation.

(5) Technical oversight of Safety Evaluation Reports to assure increased emphasis on safety while still satisfying the requirements of the administrative process of regulation.

(6) Assurance of adequate operations experience and training for the NRC technical review staff, especially those staff members assigned responsibility in accident response situations.

(7) Dedication of adequate resources to the three principal functions of the Office of Nuclear Reactor Regulation: reactor licensing, oversight of operating reactors, and resolution of generic safety issues.

(8) Use of a formal procedure for followup on questions and requests from the Advisory Committee on Reactor Safeguards and its individual members.'

Report of Special Review Group,
Office of Inspection and Enforcement,
NRC (NUREG-0616)

(d) 1. IE should reemphasize to licensees the importance of having the project manager or the station superintendent attend all IE inspection exit interviews. (2.3.3.1)

(a) 2. Meetings between senior IE regional management and senior licensee corporate management should be held annually. (2.3.3.2)

(b) 3. Improve inspector training on conducting exit interviews and other management meetings. (2,3.3.3)

(b) 4. Expand initial inspector training to include courses on basic health physics and emergency response. (2.4.1.1)

(b) 5. Define an acceptable level of plant specific knowledge needed by an operations resident inspector and develop a guided self study program to reach that goal within a specified period of time. Inspector progress should be audited by his supervisor. (2.4.1.2)

(b) 6. In addition to technical training, resident inspectors should be given training appropriate to their unique role of representing the NRC onsite. Such topics as conduct of meetings with public and media representatives should be included. Methods for keeping the resident abreast of NRC policies, decisions, and announcements should be developed. (2.4.1.3)

(b) 7. Give regional office training and annual refresher training in health physics, emergency response, and respiratory protection (including maks fitting, medical examination and bioassay) to all inspectors, so that unescorted admittance be granted to licensee facilities with only short delay for site specific orientation. Inspectors should be provided with credentials certifying receipt of training. (2.4.1.4)

(b) 8. Give health physics inspectors training on radiation protection and radwaste inspection modules to improve consistency in interpretation of requirements. Schedule refresher training on pertinent technical subjects be scheduled for health physics inspectors. (2.4.1.5)

(b) 9. Develop special courses to train IE inspectors in the proper method of conducting an investigation. (2.4.1.6)

(a) 10. The IE inspection program should be modified to emphasize assessment of the effectiveness of licensee management control systems. (2.5.1.1)

(a) 11. IE regional management should periodically review licensee inspection history for indications of management control weaknesses. Weaknesses identified should be resolved in appropriate meetings between licensee and IE management. (2.5.1.2)

(a) 12. IE regional management should participate more actively in exit and management meetings at licensee facilities to increase visibility of IE management and to strengthen the IE program. (2.5.1.3)

(a) 13. IE studies of approaches to measuring licensee performance should be reevaluated and utilized to define and implement a licensee performance appraisal system. (2.5.1.4)

(a) 14. The QA program requirements for the preoperational and startup test phase should be reemphasized by NRR by revision of the Standard Review plan.(2.5.2.1

(b) 15. The IE inspection program for the preoperational and startup test phase should be strengthened to require additional QA inspections. (2.5.2.2)

(b) 16. The IE inspection program should include a provision for a licensee/ IE management meeting to perform a final review of the operational QA program in relation to the total administrative control porgram just prior to facility operations. (2.5.2.3)

(d) 17. IE should reemphasize the importance of the QA function and require a licensee QA representative to attend IE inspection exit interviews. IE inspectors should meet with licensee QA personnel during site inspections. (2.5.2.4)

(a) 18. IE should evaluate the adequacy of the independent safety reviews at all operating plants. The review should be conducted by an independent audit group and should consider the competency of plant staff members to review proposed design changes and the interface between plant staff review, offsite review, and design groups. (2.5.4.1)

(b) 19. The NRC resident inspectors should periodically attend the onsite review group meetings. (2.5.4.2)

(b) 20. Install a dedicated telephone line between the NRC Operations Center and Tri-State, the principal commercial carrier of SNM. (3.15.5.4)

(c) 21. Consider arming the inspection teams, which could be involved in attempted diversion or sabotage of a shipment. (3.15.4.5)

(d) 22. Clarify the role of NRC Inspectors covering shipments of SNM and define the inspector's authority over the commercial transportation team. (3.15.5.6

(b) 23. Ensure that Bulletins, Circulars, Notices, and Temporary Instructions are accurate and explicit.

Involve licensees more fully in the Bulletin formulation process. Licensee review might identify ambiguities or requirements that are incorrect or unrealistic before issuing Bulletins affecting many licensees.

Temporary Instructions written in support of a Bulletin should ensure that every line item of the Bulletin is adequately inspected. TI's should not contain interpretations that the regions will then have to impose on the licensee. (3.16.1)

(b) 24. Identify in advance modules for reduced or delayed inspection effort at unaffected facilities following an accident. Consider the following examples:

Categories for reduced inspection frequency:

- --Selected Preoperational test review modules
- --Annual "routine" modules, such as review of procedures, annual QA review, etc.
- --Selected modules at facilities having an enforcement history of few noncompliances.

Categories for maintained inspection frequency:

--Quarterly Review of Plans

--Resident inspection modules

--Refueling modules

--Selected preoperational phase modules, such as containment leak rate test or RCS hydrotest modules

--Preoperational QA program inspection

--Emergency preparedness modules (3.16.2)

Three Mile Island-A Report to
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(b) 1. There should be an exchange or rotation of senior level managers on a more pre-planned basis (p.120).

(b) 2. The agency should establish a policy that practical experience in the design, construction, and operation of nuclear power plants and in the problems of radiation protection is a requisite for key staff personnel and arrange an effective program to obtain this experience for the appropriate individuals (p.120).

(b) 3. The proficiency of the IE staff and management should be increased by staff rotation (field and headquarters) and by conducting regular seminars, attended by both NRC management officials and inspectors, in order to identify problems the inspectors are encountering (p.101).

V. NRC Policy, Organization and Management

President's Commission Report

(c) 1. The Nuclear Regulatory Commission should be restructured as a new independent agency in the executive branch. (A1)

(c) 2. The present five-member commission should be abolished. (A1a)

(c) 3. The new agency should be headed by a single administrator appointed by the President, subject to the advice and consent of the Senate, to serve a substantial term (not coterminous with that of the President) in order to provide an expectation of continuity, but at the pleasure of the President to allow removal when the President deems it necessary. The administrator should be a person from outside the present agency. (A1b)

(a) 4. The administrator should have substantial discretionary authority over the internal organization and management of the new agency, and over personnel transfers from the existing NRC. Unlike the present NRC arrangement, the administrator and major staff components should be located in the same building or group of buildings. (A1c)

(a) 5. A major role of the administrator should be assuring that offices within the agency communicate sufficiently so that research, operating experience, and inspection and enforcement affect the overall performance of the agency. (A1d)

(c) 6. An oversight committee on nuclear reactor safety should be established. Its purpose would be to examine, on a continuing basis, the performance of the agency and of the nuclear industry in addressing and resolving important public safety issues associated with the construction and operation of nuclear power plants, andin exploring the overall risks of nuclear power. (A2)

(c) 7. The members of the committee, not to exceed 15 in number, should be appointed by the President and should include: persons conversant with public health, environmental protection, emergency planning, energy technology and policy, nuclear power generation, and nuclear safety; one or more state governors; and members of the general public. (A2a)

(c) 8. The committee, assisted by its own staff, should report to the President and to Congress at least annually. (A2b)

(a) 9. The Advisory Committee on Reactor Safeguards (ACRS) should be retained, in a strengthened role, to continue providing an independent technical check on safety matters. The members of the committee should continue to be part-time appointees; the Commission believes that the independence and high quality of the members might be compromised by making them full-time federal employees. (A3)

(a) 10. The staff of ACRS should be strengthened to provide increased capacity for independent analysis. Special consideration should be given to improving ACRS' acpabilities in the field of public health. (A3a)

(a) 11. The ACRS should not be required to review each license application. When ACRS chooses to review a license application, it should have the statutory right to intervene in hearings as a party. In particular, ACRS should be authroized to raise any safety issue in licensing proceedings, to give reasons and arguments for its views, and to require formal response by the agency to any submission it makes. Any member of ACRS should be authorized to appear and testify in hearings, but should be exempt from subpoena in any proceedings in which he has not previously appeared voluntarily or made an individual written submission.(A3b)

(a) 12. ACRS should have similar rights in rulemaking proceedings. In particular, it should have the power to initiate a rulemaking proceeding before the agency to resolve any generic safety issue it identifies. (A3c)

TMI-2 Lessons Learned Task Force Status
Report and Short-Term Recommendations
(NUREG-0578)

(None)

TMI-2 Lessons Learned Task
Force Final Report

(a) 1. The Commission should undertake with the staff the development and articulation of clear criteria to define the basic safety goal for nuclear power plant regulation. Since this goal will be used as a benchmark by the staff in defining new regulatory requirements, definitive policy guidance should also be developed regarding the threshold for backfitting of new requirements to existing plants. The Task Force believes that the goal should be supplemented where possible with quantitative reliability or risk criteria, with limitations being placed on their use to assure that such criteria do not impede the capability for timely decisionmaking.(11)

Report of Special Review Group,
Office of Inspection and Enforcement,
NRC (NUREG-0616)

(d) 1. Develop guidance for the resident inspector to relay for further NRC analysis information about events not reported by the licensee. (2.7.1)

(a) 2. A headquarters Support Group should be established or an existing technical group expanded to include specialists in such areas as instrumentation, core physics, mechanical and electrical engineering and thermal-hydraulics. This group would work full time doing in-depth analyses or LERs and would select events for analysis by the Event

Analysis Group described below. Expanded computer searches for related events could be done by this group. (2.7.2)

(a) 3. A standing Headquarters based Event Analysis Group should be established to analyze events at licensed facilities. This group should consist of technical representatives from IE, NRR, the NSSSs and the AEs. (2.7.3)

(a) 4. Achieve statutory recognition of IE to formalize its entire mission. (3.2.1)

(b) 5. Publish in the NRC Manual statements of NRC policy regarding emergency dose limits and whether an employee has the right to refuse assignments, during both normal and emergency conditions, because of the potential for radiation exposure. (3.6.4)

(d) 6. Publish a statement of NRC policy regarding the relative importance of controlling access to Part 50 and 70 facilities to satisfy Part 73 and of permitting access to such facilities to perform tasks essential to safety. Also, require that the topic be adressed in licensee contingency plans. (3.6.5)

(b) 7. Establish an Office of Training, which would operate an NRC Training Center. Locate the NRC Training Center to task advantage of similator facilities and existing reactor proximity; for example, near the TVA Training Center in Chattanooga, Tennessee. New IE personnel should attend appropriate Training Center courses, or receive certification of competence, before being allowed to conduct unescorted inspections or being assigned lead responsibility for a facility. Existing IE inspectors should be certified or should attend appropriate Training Center courses until certification is received. The Training Center should conduct for IE, as a minimum, courses dealing with the following:
(Note: The Special Review Group listed 1 1/2 pages of specific recommendation which are not included here.) (3.7.2.1)

(b) 8. Promptly establish training and certification programs to prepare reactor resident inspectors to be responsive in the event of an accident, as well as to perform routine inspections. Certify both existing and new resident inspectors. (Note: The Special Review Group listed 1 1/2 pages of specific recommendations which are not included here.) (3.7.2.2)

(b) 9. To provide for individual recognition and documentation, develop a program leading to a Senior Resident Inspector (SRI) certification; which requires the inspector to have site-specific knowledge adequate to ensure facility comprehension and the ability to evaluate transients and accidents. This will require knowledge at a level adequate to direct licensee actions, if necessary. (3.7.2.3)

(b) 10. Office Directors should identify courses to be offered by the Office of Training for their staffs. This may include short courses for supervisors or courses in a specific discipline or technical area. (3.7.3.2)

(b) 11. The Office of Training should develop a curriculum to meet the needs of other NRC offices. (3.7.3.3)

(d) 12. Place increased emphasis on completing the Investigation Manual chapter presently under development. (3.10.1)

(d) 13. Promptly redelegate to appropriate inspectors and investigators the authority to administer oaths and affirmations following emergencies. (3.10.2)

(d) 14. Retain professional transcription service to work with investigation teams at accident locations. Also, assign a permanent clerical staff to the teams to handle administrative and clerical functions. (3.10.3)

(d) 15. Assign a member of ELD legal staff to each accident investigation team to provide such assistance as may be needed. (3.10.6)

(d) 16. IE should provide guidance regarding the role of the investigator in the conduct of joint investigations with other agencies. (3.10.7)

(d) 17. Encourage regional offices to develop and maintain liaison with outside investigative agencies (e.g., Federal Bureau of Investigation; Drug Enforcement Agency; Alcohol Tobacco, and Firearms; Secret Service; Customs; and State Police Organizations). (3.10.8)

(d) 18. Provide each resident inspector a "beeper", the beeper number to be kept by the regional office, the NRC Operations Center, and the licensee. If available, the beeper should be of the voice-message type. It is recognized that there will be times when the beeper is out of range or otherwise unavailable and that not all reactor locations have a local beeper service. The purpose of the beeper is to increase the probability that residents can be reached. (3.11.7.1)

(d) 19. Provide each resident a four-wheel drive vehicle equipped with two-way radio to the facility and a mobile telephone. (3.11.7.2)

(d) 20. Evaluate and standardize IE's capability for recording information and provide adequate supplies of logs, forms, recording devices, and other needs. Train IE personnel in the general area of information recording and in specific techniques used by NRC and licensees at various sites. (3.12.2)

Three Mile Island-A Report to the Commissioners and to the Public (Rogovin)

(b) 1. Utilities not meeting safety requirements regarding technical or management competence could be placed into "receivership" by the NRC. Their operation (or construction) then would be undertaken by the consortium as a condition of the NRC license (p.110).

(c) 2. There is a central and overwhelming need for legislative and executive reorganization to establish a single chief executive with the clear authority to supervise and direct the entire NRC staff. We do not believe that the current administration's proposal to strengthen the NRC Chairman's executive authority goes far enough. (p. 115-117).

(c) 3. The single administrator should be responsible directly to the Executive Branch, and to Congress through strong congressional oversight.

(b) 4. The Administrator should formulate an ultimate safety objective for the regulatory program in the first instance for review and approval by the President and Congress, and then when a standard is approved should apply it (p. 116).

(b) 5. Decisions about the ultimate safety objective in the regulated program and about the expansion or reduction of our country's reliance on nuclear power should be made by the Executive and Congress as part of our national energy strategy (p. 91).

(b) 6. A number of existing plants now owned by different utilities could be owned an/or constructed or operated by an industry-wide consortium or a public corporation similar to COMSAT (p. 110).

(c) 7. The Board should not duplicate the functions of any office or provide another layer in the review process, but should instead: (1) exercise oversight in the effectiveness of the licensing review process and the regulation of existing plants; (2) advise the Commissioners on regulatory goals and important issues for rulemaking; (3) act as an Ombudsman group to receive complaints and technical dissents; (4) enhance reactor safety by monitoring the effectiveness of the Office of Analysis and Evaluation of Operational Data; (5) monitor the staff's use of the latest analytical and design tools; (6) develop and maintain a capacity to investigate accidents and important safety-related incidents, independent of other offices and the Commission or Administrator; and (7) provide a quality assurance function for the agency's regulatory process as a whole (p. 118, 119).

(b) 8. The Atomic Safety and Licensing Appeal Board should not, by default of the Commission, have to continue to interpret, "improve" and apply ambiguous standards (p. 140).

(b) 9. The Ratchet Committee's function is of sufficient importance to warrant its deliberations to be reported in some depth if not actually transcribed completely (p. 146).

(b) 10. The voting members of the Ratchet Committee should be lower than Office or Division Director level (p. 146).

(b) 11. Additional steps should be taken to increase the opportunity for industry, public, and ACRS involvement in the issues considered by the Ratchet Committee functioning (p. 146).

Summary of NRC's TMI Action Plan

This document includes a short description of the TMI Action Plan tasks and a listing of the specific action items proposed under each task. Also presented are the NRC and industry priorities for each action along with their respective costs and schedules.

Following each Action Plan task are the TMI-related recommendations that apply to the task. These recommendations were made in the:

(1) President's Commission Report on the Accident at TMI,
(2) TMI-2 Lessons Learned Task Force Status Report and Short-Term Recommendations (NUREG-0578),
(3) TMI-2 Lessons Learned Task Force Final Report (NUREG-0585)
(4) NRC Special Inquiry Report (Rogovin study),
(5) NRC's Bulletins and Orders Task Force Reports, and the
(6) Report of the Special Review Group, Office of Inspection and Enforcement, NRC (NUREG-0616).

Not included are the recommendations of the Advisory Committee on Reactor Safeguards (ACRS). These recommendations were contained in numerous ACRS letters and documents which did not lend themselves to quick review and summary. We were assured, by both NRC and ACRS officials, however, that all ACRS concerns were incorporated into the TMI Action Plan--except three. These exceptions include the (1) analysis of steam generator overfilling and equivalent boiling water reactor transient, (2) seismic implications of TMI, and (3) quantitative safety goals.

For the most part, the information in this document reflects NRC's March 5, 1980, draft TMI Action Plan. Since then NRC has continued to identify, consider and include many recommendations that do not appear under specific tasks in this document. A more updated status of recommendations will be provided by Volume 2 of the TMI-2 Action Plan. The exceptions are the priorities, costs, and schedules which were updated to reflect information in NRC's latest draft Action Plan dated May 1980.

Task I.A.1: Operating Personnel and Staffing

This task is to increase the capability of the shift crew in the control room to operate the facility in a safe and competent manner at all times by assuring proper qualification and fitness of the crew.

ACTION ITEMS	PRIORITY		ESTIMATED COST			SCHEDULE	
	NRC's	Industry's	NRC		Industry	Begin	End
			1980	1981	1980 - 1981		
1. Shift Technical Advisor	1	-	.8my $25K	.6my $15K	$500K per site per year	1979	1981
2. Shift Supervisor Administrative Duties	1	-	.1my	-	NONE	Complete	
3. Shift Manning	1	2	.6my	-	$400K per year	1980	1982
4. Long-term Upgrading	To be scheduled and assigned resources along with normal agency functions.						

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. The agency should be directed to upgrade its operator and supervisor licensing functions. These should include the accreditation of training institutions from which candidates for a license must graduate. Such institutions should be required to employ qualified instructors, to perform emergency and simulator training, and to include instruction in basic principles of reactor science, reactor safety, and the hazards of radiation. The agency should also set criteria for operator qualifications and background investigations, and strictly test license candidates for the particular power plant they will operate. The agency should periodically review and reaccredit all training programs and relicense individuals on the basis of current information on experience in reactor operations. (A.4.a)

2. It is important to attract highly qualified candidates for the positions of senior operator and operator supervisor. Pay scales should be high enough to attract such candidates. (B.4)

TMI-2 LESSONS LEARNED TASK FORCE STATUS REPORT AND SHORT-TERM RECOMMENDATIONS (NUREG-0578)

1. Review plant administrative and management procedures. Revise as necessary to assure that reactor operations

command and control responsibilities and authority are properly defined. Corporate management shall revise and promptly issue an operations policy directive that emphasizes the duties, responsibilities, and authority and lines of command of the control room operators, the shift to technical advisor, and the person responsible for reactor operations command in the control room. (2.2.1a)

2. Provide on shift at each nuclear power plant a qualified person (the shift technical advisor) with a bachelor's degree or equivalent in a science or engineering discipline and with specific training in the plant response to off-normal events and in accident analysis of the plant. Shift technical advisors shall serve in an advisory capacity to shift supervisors. The licensee shall assign normal duties to the shift technical advisor that pertain to the engineering aspects of assuring safe operations of the plant, including the review and evaluation of operating experience. (2.2.1b)

TMI-2 LESSONS LEARNED TASK FORCE FINAL REPORT (NUREG-0585)

1. The Commission's regulations should be revised to more clearly state present staff requirements (as described in the Standard Review Plan, Section 13.1.2) for minimum shift staffing of licensed reactor operators. The governing regulation, 10 CFR 50.54(k), states that "an operator or senior operator licensed pursuant to Part 55 of this chapter shall be present at the controls at all times during operation of the facility." For single-unit power stations, the staff requires the shift crew to include at least one licensed senior reactor operator, two licensed reactor operators, and two additional operators (auxiliary operators) during reactor operation. For multiple-unit power stations with a common control room, the staff permits a reduction of licensed reactor operators to one per unit plus one additional reactor operator with the other requirements remaining the same. However, the staff does not require the presence in the control room at all times of two licensed operators and the senior reactor operator. In developing the revision to the regulations, consideration should be given to requiring the presence in the control room at all times during normal operations of two reactor operators and one senior reactor operator. Provisions for tours of the plant by operators will probably need to be made if this staffing proposal is adopted. (2)

2. Each licensee should be required to review and revise within 90 days the plant administrative procedures to assure that a sound policy is established covering working hours for reactor operators and senior reactor operators. It is recognized that this is a complex subject involving other interests (e.g., labor unions). The NRC staff should assure that the subject is addressed in a comprehensive manner by all licensees and that the other interests not be allowed to interfere with the basic safety interest. As general guidance, it is expected that licensees' administrative procedures will make it unlikely that personnel would have to be used for more than two consecutive work periods in excess of 12 hours and that a 12-hour rest period would be required between work periods. In the event that special circumstances arise that would cause extended periods of work in excess of 12 hours for more than two consecutive days, such work should be authorized by the Station Manager with appropriate documentation of the cause. Indications aside from Three Mile Island lead the Task Force to conclude that this step must be taken to reasonably assure that individuals are in proper physical condition to perform work at nuclear power plants. (3)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. We think the NRC should require every licensee to hire a cadre of engineers knowledgeable in reactor engineering and physics. Each should be provided with training in the specific characteristics of the plant at least equivalent to that received by a senior reactor operator, with special emphasis on integrated plant response and transient behavior. The utility should be required to deploy at least one such engineer supervisor, whose qualifications have been examined by the NRC, as shift manager on every shift in direct control of the shift crew. (p. 106)

2. We believe that qualified engineering personnel must be required in the supervisory chain of command on each shift, and that these personnel be qualified and examined by the NRC for intimate knowledge of the systems and behavior of the plant for which they will have responsibility. (p. 106)

3. Minimum manning requirements for each shift needs to be increased by NRC. (p. 106)

NRC'S BULLETINS AND ORDERS TASK FORCE RECOMMENDATIONS

1. Until long-term design change requirement of IEB 79-06C is implemented:

    (a) Upon reactor trip and HPI initiation caused by RCS low pressure, immediate trip all operating RCPs;

    (b) Provide two operators in CR at all times to accomplish RCP trips (three operators for dual CR facility. (C.1.4c)

2. Two operators in the control room. (C.3.54)

Task I.A.2: Training and Qualification of Operating Personnel

The objective is to increase the education, experience, and training requirements for operators, senior operators, supervisors and other personnel in the operations organization to substantially increase their capability to perform their duties.

ACTION ITEMS	PRIORITY		ESTIMATED COST			SCHEDULE	
	NRC's	Industry's	NRC		Industry	Begin	End
			1980	1981	1980 - 1981		
1. Immediate Upgrading of Operator and Senior Operator Training and Qualifications	1	1, 2, 3 (Parts)	.8my $8K	.1my $3K	$30K per year per plant	1980	1980
2. Training and Qualifications of Operations Personnel	2	2	.1my $10K	.1my	$50K per year per plant	1980	1982
3. Administration of Training Programs	2	-	.6my	1.4my $7K	$30K per year per plant	1980	1982
4. Nuclear Reactor Regulation Participation in Inspection and Enforcement Inspector Training	3	-	.1my per year		NONE	1982	--
5. Plant Drills (short-term)	1	3	.1my	.1my	1.5my $25K	1980	1981
6. Long-term Upgrading of Training and Qualifications	1	-	2.4my $228K	3.73my $31K	$6M capital cost $300K per year	1980	To be determined
7. Accreditation of Training Institution	2	-	.3my $87K	.3my $14K	None given	1980	1982

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. The agency should be directed to upgrade its operator and supervisor licensing functions. These should include the accreditation of training institutions from which candidates for a license must graduate. Such institutions should be required to employ qualified instructors, to perform emergency and simulator training, and to include instruction in basic principles of reactor science, reactor safety, and the hazards of radiation. The agency should also set criteria for operator qualifications and background investigations, and strictly test license candidates for the particular power plant they will operate. The agency should periodically review and reaccredit all training programs and relicense individuals on the basis of current information on experience in reactor operations. (A.4.a)

2. The Commission recommends the establishment of agency-accredited training institutions for operators and immediate

supervisors of operators. These institutions should have highly qualified instructors, who will maintain high standards, stress understanding of the fundamentals of nuclear power plants and the possible health effects of nuclear power, and who will train operators to respond to emergencies. (C.1)

3. Individual utilities should be responsible for training operators who are graduates of accredited institutions in the specifics of operating a particular plant. These operators should be examined and licensed by the restructured NRC, both at their initial licensing and at the relicensing stage. In order to be licensed, operators must pass every portion of the examination. Supervisors of operators, at a minimum, should have the same training as operators. (C.2)

4. Training should not end when operators are given their licenses. (C.3)

5. Each utility should have ready access to a control room simulator. Operators and supervisors should be required to train regularly on the simulator. The holding of operator licenses should be contingent on performance on the simulator. (C.3.d)

TMI-2 LESSONS LEARNED TASK FORCE FINAL REPORT (NUREG-0585)

1. The corporate management of each licensee should establish a definitive presence and involvement in the selection, training, and qualification of operations personnel. To assure that this has been accomplished, the NRC should require, as part of the application for operator and senior operator licenses, that corporate management certify the competence and fitness of the applicants. Such certification should be required by the highest level of corporate management responsible for plant operation (for example, the Vice-President for Operations). The Task Force recommends that, when the NRC staff judges the quality of applications from a particular utility to be deficient, the corporate official certifying the competence of the applicants be required to discuss the reasons for the decline in competence and planned corrective action with the Director of Nuclear Reactor Regulation. (1.1)

2. Each licensee should be required to review, within one year, its training program for all operations personnel,

including maintenance and technical personnel, and should justify the acceptability of training programs on the basis that these programs provide sufficient assurance that safety-related functions will be effectively carried out. Documentation of this review and justification should be retained on site for inspection, but need not be submitted to the NRC for review. The preferred method of fulfilling this recommendation is a position task analysis, in which the tasks performed by the person in each position are defined and the training, in conjunction with education and experience, is identified to provide assurance that the tasks can be effectively carried out. The position task analysis should include normal and emergency duties, including maintenance activities, placing emphasis on the role played by every member of the operations organization in assuring safe plant operations. All levels of the operations organization should be included. This action is regarded by the Task Force as an interim measure pending resolution of the question of licensing of additional operations personnel beyond reactor operators and senior reactor operators, as discussed in Recommendation 1.8 of this appendix.

The scope of emergency duties defined in the position task analysis should not be restricted to only the transients and accidents considered in the design basis. The training should recognize that events beyond the current licensing design basis events can occur.

The training should include the use of the systems already installed at the plant to control or mitigate the consequences of accidents in which the core is severely damaged. This training would be an interim measure pending completion of the rulemaking to determine what design features to mitigate these more severe accidents should be required. (1.2)

3. Each licensee should be required to review, within 90 days, its training program with respect to the conduct of in-plant drills. For tasks performed by shift operation personnel in response to off-normal or accident situations, licensees should assure that sufficient in-plant drills are conducted to enable personnel to maintain proficiency in those tasks. The Task Force considers drills of a walk-through nature acceptable and does not mean to imply the actual manipulation of controls or equipment or initiation of an event (such as by the opening or closing of valves or tripping breakers or pumps). The Task Force considers that drills requiring

the physical manipulation of controls are also important but can be more efficiently and safely conducted using an appropriate nuclear power plant simulator. With this in mind, each licensee should develop a schedule for in-plant drills. This schedule should be a part of a disciplined training program for each station. It need not be submitted to the NRC for review; however, it should be available at the site for inspection. (1.3)

4. The first areas of personnel qualification that need to be upgraded are those pertaining to licensed senior reactor operators and reactor operators. NRR recommendations to the Commission for improvements in the operator licensing program were contained in Commission Paper SECY 79-330E (Ref. 2). We believe these recommendations should be treated as the first steps in a long-term program to upgrade operator proficiency. They are, however, necessary improvements in the program. The ultimate resolution of the issue of qualifications of reactor operators should take a broader perspective. Although the Task Force generally agrees with the recommendations contained in SECY 79-330E, we recommend implementation of the following additional items by the regulatory staff in conjunction with the implementation of the recommendations in SECY 79-330E.

(a) As part of the inspector training program of the Office of Inspection and Enforcement (IE), operator licensing program personnel of the Office of Nuclear Reactor Regulation should (a) provide information to IE inspectors on the operator licensing program and (b) identify the types of information the IE inspectors should provide to assist NRR in making decisions with regard to the renewal of operator licenses.

(b) The NRC staff should establish a mechanism whereby individuals committing operational errors are identified in Licensee Event Reports. Such a mechanism should include provisions for protection of the privacy of the individual. The intent of this recommendation is to assist them in determining the continued qualification of operators in the review of operator license renewal applications. Due consideration should be given to whether such reporting will affect the quality of reports received by the NRC.

(c) As part of the training program for all licensed operators, a one-week course should be conducted by the NRR operator licensing program personnel with assistance from other NRR technical personnel. Particulars of the course would include:

(1) Safety analyses
(2) Probabilistic assessments
(3) Current safety issues and recent significant operating experience
(4) NRC and industry responsibilities for safety.

This recommendation would reinforce the knowledge of and respect for accident/transient sequences as well as providing a positive feedback for better decisions by NRC staff on reactor operations and design matters. Additional NRC staffing will be required to accomplish this objective.

(d) Prior to assuming initial assignment as shift supervisor or shift technical advisor and on a biennial basis thereafter, individuals should be interviewed by an interdisciplinary group of NRC staff. Such interviews should probe the individual's technical knowledge in the area of transient and accident response and, in the case of a shift supervisor, the managerial ability to command and control the activities of shift personnel.

These interviews should be conducted at NRC headquarters. Criteria for subjects to be covered and acceptable standards of performance of individuals should be developed by NRR operator licensing personnel prior to promulgation of this requirement. This action will require a considerable expenditure of resources and its phasing needs to be carefully considered.

(e) The NRR operator licensing program personnel should sponsor an annual workshop for licensed operators to be attended by at least one representative of the licensed shift personnel at each unit. The purpose of this workshop is to provide an opportunity for exchange of information on operating experiences between the NRC staff and the utility shift personnel. For example, such a seminar could lead to an exchange of information on (a) NRC safety concerns related to shift operations, (b) the impact of licensing on shift activities and personnel, and (c) recommendations from shift personnel concerning changes in reactor regulation that would improve safety.

(f) As a less prescriptive alternative to Recommendation 6 of SECY 79-330E that "Phase II, III, and IV cold training program instructors and all hot training program instructors that provide instruction in nuclear power plant operations hold senior operator licenses and be required to successfully participate in applicable requalification programs to maintain their instructor status." The following is considered acceptable: Such instructors should hold or have previously held a senior reactor operator (SRO) license on a comparable nuclear power plant and currently possess instructor certification from the Institute of Nuclear Power Operations, provided the INPO certification program has been examined and found acceptable to the NRC. Emphasis should be placed on an instructor's ability to instruct, in addition to his technical competence.

(g) Consideration should be given to placing resident operator licensing examiners in each of the major geographical areas in which there is a concentration of training centers using nuclear power plant simulators. The intent of this recommendation is to provide for greater interaction by operator licensing examiners in operator qualification and requalification programs. (1.A)

5. A program for raising the qualification requirements for shift supervisors and senior reactor operators should be established. The distinction being made in present practice between senior reactor operators (e.g., shift foreman in a multi-unit station) and shift supervisors should be recognized. As a short-term action pursuant to NUREG-0578 (until such time as staffing and qualification of shift personnel and the control room man-machine interface requirements are upgraded), each licensee has been required to provide an on-shift technical advisor to the shift supervisor. Within the next five years, it is recommended that the qualifications of senior reactor operators and shift supervisors be upgraded as indicated below. Qualification requirements for applicants for licensing prior to initial fuel loading may require special additional considerations, particularly with respect to experience.

(a) Shift Supervisor (person in charge of operations on shift at the station) - Shift Supervisors should have at least a Bachelor of Science degree or equivalent training and experience in engineering or the related physical sciences. The Shift Supervisor should also hold a senior reactor operator's license (issued under new proposed requirements defined below) and have served as a reactor operator for one year or senior reactor operator for six months. In establishing equivalency with a Bachelor of Science degree, consideration should be given not only to formal courses in engineering and related sciences, but also to education in the liberal arts. It is recommended that the use of the equivalency to a Bachelor of Science degree be exercised to only a limited degree and that most shift supervisors hold degrees. It is also recommended that shift supervisor qualifications include leadership training and experience.

(b) Senior Reactor Operator (e.g., shift foreman in a multi-unit station) - Senior Reactor Operators should have at least the same general technical education and specific training in transient and accident response characteristics of nuclear power plants as recently articulated for the shift technical advisor. Additional recommendations for upgrading senior reactor operator qualifications are identified in the Commission Paper SECY 79-330E on Qualification of Reactor Operators.

(c) At present, a basic fundamentals course of approximately twelve weeks is required as part of the operator training program. A prerequisite to satisfactory performance of nuclear power operation is the fundamental understanding of nuclear technology. The Task Force believes twelve weeks to be insufficient time to provide a broad and comprehensive level of understanding in the fundamentals of nuclear technology. It is recommended that the NRC, perhaps in consultation with INPO, examine the content of the basic fundamentals course and establish definitive instructional requirements for the course. (1.5)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. There is a clear need for more operator training with emphasis on response to emergencies and on system diagnosis. (p. 105)

2. The NRC should assume a direct role in the training of operators including certification of training facilities, establishment of a minimum curriculum, and certification of instructors. (p. 105)

3. Operators must be trained as a team on the simulator with more emphasis on response to emergencies and on system diagnosis. (p. 105)

4. NRC should require every licensee to hire a cadre of graduate engineers knowledgeable in reactor engineering and physics. Each should be provided with training in the specific characteristics of the plant, with special emphasis on integrated plant response and transient behavior. The utility should be required to deploy at least one such engineer supervisor whose qualifications have been examined by the NRC as shift manager (not as an "advisor") on every shift. (p. 106)

5. We believe the NRC should satisfy itself that every applicant for an OL has evaluated:

(1) The management and technical qualifications of its site crews and site management, and their familiarity with the new plant.

(2) Emergency operator procedures, which should be examined thoroughly to identify whether they may be conflicting or could in some other fashion mislead the operators.

(3) The control room, which should be examined to identify outstanding human factors deficiencies and any instrumentation problems.

(4) The training program for the new operators. (p. 146)

(5) A substantially more detailed and upgraded set of requirements should be developed by the NRC for

technically competent, NRC-certified, supervisory and management officials to be present on each shift to direct operations. (p. 106)

NRC'S BULLETINS AND ORDERS TASK FORCE RECOMMENDATIONS

1. Review TMI-2 PNs and detailed chronology of the TMI-2 accident. (C.1.1)

2. Review transients similar to TMI-2 that have occurred at other facilities and NRC evaluation of Davis-Besse transient. (C.1.2)

3. Make all operating and maintenance personnel aware of the seriousness and consequences of the erroneous actions taken leading up to, and in early phases of, the TMI-2 accident. (C.1.11)

4. Operator training and drilling. (C.2.11)

5. Simulator training requirements. (C.3.57)

REPORT OF THE SPECIAL REVIEW GROUP, OFFICE OF INSPECTION AND ENFORCEMENT, NRC (NUREG-0616)

1. The NRC should form a group with representatives from IE, NRR, and Office of Standards Development (OSD) which would be responsible to establish minimum competency standards for various categories of unlicensed plant and refresher programs. The group should consider the extent of radiation protection refresher training needed by the various groups. Exchange with industry and professional groups is encouraged. (2.4.2.1)

2. The feasibility of establishing some form of "ability to perform test" should be investigated. (2.4.2.7)

Task I.A.3: Licensing and Requalification of Operating Personnel

The objective of this task is to upgrade the requirements and procedures for nuclear powerplant operators and supervisors licensing to assure that safe and competent operators and senior operators are in charge of the day-to-day operation of nuclear powerplants. Increase the requirements for initial issuance of licenses and for license renewals and provide closer NRC monitoring of licensed activities.

ACTION ITEM	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC		Industry		Begin	End
			1980	1981	1980	1981		
1. Revise Scope and Criteria for Licensing Exams	2	2, 3 (Parts)	5.5my	4.3my	$100K initially plus $100K per plant per year		1980	1980
2. Operator Licensing Program Changes	3	-	-	-	NONE		1982 or later	-
3. Requirements for Operator Fitness	To be scheduled and assigned resources along with normal agency functions.							
4. Licensing of Additional Operations Personnel	2	-	-	-	-	-	1982 or later	-
5. Establish Statement of Understanding with INPO and DOE	To be scheduled and assigned resources along with normal agency functions.							

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. Individual utilities should be responsible for training operators who are graduates of accredited institutions in the specifics of operating a particular plant. These operators should be examined and licensed by the restructured NRC, both at their initial licensing and at the relicensing stage. In order to be licensed, operators must pass every portion of the examination. Supervisors of operators, at a minimum, should have the same training as operators. (C.2)

2. Training should not end when operators are given their licenses. (C.3)

3. Such training must be continuously integrated with operating experience. (C.3.b)

TMI-2 LESSONS LEARNED TASK FORCE FINAL REPORT (NUREG-0585)

1. The NRC staff should establish a mechanism whereby individuals committing operational errors are identified in Licensee Event Reports. Such a mechanism should include

provisions for protection of the privacy of the individual. The intent of this recommendation is to provide additional information to operator licensing program personnel to assist them in determining the continued qualifications of operators in the review of operator license renewal applications. Due consideration should be given to whether such reporting will affect the quality of reports received by the NRC. (1.4.2)

2. Prior to assuming initial assignment as shift supervisor or shift technical advisor and on a biennial basis thereafter, individuals should be interviewed by an interdisciplinary group of NRC staff. Such interviews should probe the individual's technical knowledge in the area of transient and accident to command and control the activities of shift personnel. These interviews should be conducted at NRC headquarters. Criteria for subjects to be covered and acceptable standards of performance of individuals should be developed by NRR operator licensing personnel prior to promulgation of this requirement. This action will require a considerable expenditure of resources and its phasing needs to be carefully considered. (1.4.4)

3. Consideration should be given to placing resident operator licensing examiners in each of the major geographical areas in which there is a concentration of training centers using nuclear power plant simulators. The intent of this recommendation is to provide for greater interaction by operator licensing examiners in operator qualification and requalification programs. (1.4.7)

4. The staff should decide which plant personnel, other than reactor operators and senior reactor operators, should be licensed. NRC review of the training and qualifications of nonlicensed personnel has been very limited in the past, based on the assumption that it is the licensed operators who have the most important influence on plant safety. A number of examples from the TMI-2 accident indicate the degree to which plant safety can be greatly influenced by persons in many positions, including managers, engineers, auxiliary operators, maintenance personnel and technicians. All of these previously nonlicensed personnel may affect plant operation, and their roles should receive greater attention from a safety perspective. Answering the questions of how much independent examination of their qualifications and training is necessary and whether NRC licensing is appropriate is a signficant undertaking. The prerequisites to an effective examination program are definitive qualifi-

cation requirements and specific training programs. The current NRC guidelines addressing nonlicensed personnel training and qualification are very general and are not suitable for a licensing program.

The newly formed Institute of Nuclear Power Operations intends to develop standardized training requirements for technicians and nonlicensed operators and to provide certification for the training of these personnel. The Task Force believes this program, if properly implemented in a timely way, could substitute for detailed guidance from NRC, and could, under the right conditions, be endorsed by NRC as meeting its independent licensing requirements for additional operating personnel. A statement of understanding between INPO and the NRC should be established at an early date (within the next six months) so that both groups can decide whether and to what extent to proceed independently. (1.8)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. We suggest that a number of existing plants now owned by different utilities could be operated (and new plants constructed) by an industry-wide consortium or a public corporation such as COMSAT. This entity would manage the plants; select, train, and employ operators, supervisors, and engineers; standardize operating conditions and procedures; and, with the cooperation of vendors, systematically evaluate operating experience and implement changes in design or operations. Operating budgets could then be developed on a system-wide basis. (p. 110)

2. We believe the NRC should satisfy itself that every applicant for an OL has evaluated:

(a) The management and technical qualifications of its site crews and site management, and their familiarity with the new plant.

(b) Emergency operator procedures, which should be examined thoroughly to identify whether they may be conflicting or could in some other fashion mislead the operators.

(c) The training program for the new operators. (p. 146)

3. We urge the rapid implementation of the industry-wide Institute of Nuclear Power Operation (INPO) to evaluate operating information and problems and police and upgrade the management and operating competence of its members.

NRC'S BULLETINS AND ORDERS TASK FORCE RECOMMENDATIONS

1. Review TMI-2 PNs and detailed chronology of the TMI-2 accident. (C.1.1)

2. Review transients similar to TMI-2 that have occurred at other facilities and NRC evaluation of David-Besse transient. (C.1.2)

3. Operators are instructed not to rely on level indication alone in evaluating plant conditions. (C.14d)

4. Make all operating and maintenance personnel aware of the seriousness and consequences of the erroneous actions taken leading up to, and in early phases of, the TMI-2 accident. (C.1.11)

5. Revise emergency procedures and train RO's and SRO's (C.1.26)

6. Small-break LOCA analysis, procedures, and operator training. (C.2.4)

7. Complete TMI-2 simulator training for all operators. (C.2.5)

8. Operator training and drilling. (C.2.11)

9. Simulator training requirements. (C.3.57)

REPORT OF THE SPECIAL REVIEW GROUP, OFFICE OF INSPECTION AND ENFORCEMENT, NRC (NUREG-0616)

1. The NRC should form a group with representatives from IE, NRR, and Office of Standards Development (OSD) which would be responsible to establish minimum competency standards for various categories of unlicensed plant and contractor personnel and to define correspondingly acceptable training and refresher programs. The group should consider the extent of radiation protection refresher training needed

by the various groups. Exchange with industry and professional groups is encouraged. (2.4.2.1)

2. The group should identify regulatory changes needed to make the standard enforceable. NRC licensing and/or recognition of certification by other cognizant groups should be considered. (2.4.2.2)

3. IE, with the assistance of NRR should develop a program for continuing verification of licensed operator competence. The program should factor in the recommendations of the NRR Lessons Learned Task Force and should extend beyond training records verification to direct interaction with the operator. It should also include review of operator performance on the simulator in routine and abnormal situations. Qualification standards for the examiners/inspectors should be established. (2.4.2.5)

Task I.A.4: Simulator Use and Development

The objective is to establish and sustain a high level of realism in the training and retraining of operators, including dealing with complex transients involving multiple permutations and combinations of failures and errors. Another overall objective is to improve diagnostic capability and general knowledge of nuclear powerplant systems.

ACTION ITEMS	PRIORITY		ESTIMATED COST			SCHEDULE	
	NRC's	Industry's	NRC		Industry	Begin	End
			1980	1981	1980 - 1981		
1. Initial Simulator Improvement	1	2	1.2my $95K	.8my	$50K - $250K per simulator	1979	1982
2. Long-Term Training Simulator Upgrade	2	2	.7my $207K	1.2my $612K	Up to $6M per simulator	1980	To be determined
3. Feasibility Study of Procurement of NRC Training Simulator	To be scheduled and assigned resources along with normal agency functions.						
4. Feasibility study of NRC Engineering Computer	To be scheduled and assigned resources along with normal agency functions.						

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. Emphasis must be placed on diagnosing and controlling complex transient and on the fundamental understanding of reactor safety. (C.3.c)

2. Research and development should be carried out on improving simulation and simulation systems: a) to establish and sustain a higher level of realism in the training of operators, including dealing with transients; and b) to improve the diagnostics and general knowledge of nuclear power plant systems. (C.4)

3. The Commission recommends that continuing in-depth studies should be initiated on the probabilities and consequences (on-site and off-site) of nuclear power plant accidents, including the consequences of meltdown. (D.4)

TMI-2 LESSONS LEARNED TASK FORCE FINAL REPORT (NUREG-0585)

1. We recommend that the Office of Nuclear Regulatory Research formulate a program to establish a technical basis for definitive licensing criteria for manual and automatic operations for systems which execute plant safety functions and safety-related functions. The study should include examination of the feasibility of backfit of its conclusions and recommendations to operating plants. The role of the operator should be specifically examined. Complexity of the

safety function, the rapidity of the initiating events, the response time available to diagnose the event and to implement corrective action, and verification of the corrective action should be considered in the program. The scope of the proposed study includes the operator, the control room, displays and instrumentation, in addition to the manual and automatic controls that execute safety functions. The research team should consist of human factors engineers, control engineers, and nuclear system engineers and analysts. (7.4)

NRC'S BULLETINS AND ORDERS TASK FORCE RECOMMENDATIONS

1. Simulator upgrade for small break LOCAs. (C.3.55)

Task I.B.1: Management for Operations

The objective is to improve licensee safety performance and ability to respond to accidents by upgrading the licensee groups responsible for radiation protection and plant operation. The areas to be upgraded include (1) staff size; (2) education and experience of staff members; (3) plant operating and emergency procedures; (4) management awareness of and attention to safety matters; and (5) numbers and types of personnel available to respond to accidents. Licensee safety performance would be further improved if (1) a full-time, dedicated, onsite safety engineering staff were established; and (2) an integrated program for the systematic review of operating experience were provided with the concurrent dissemination of information on plant personnel.

ACTION ITEMS	PRIORITY		ESTIMATED COST			SCHEDULE	
	NRC's	Industry's	NRC		Industry	Begin	End
			1980	1981	1980 - 1981		
1. Organization and Management Long-Term Improvements	1	3	3.9my $162K	2.6my $17K	4my per utility 6my per facility	1979	1982
2. Evaluation of Organization and Management Improvements of NTOL Applicants	1	-	2.6my	2.9my	6my per plant	Implementation prior to fuel loading	
3. Loss of Safety Function	2	3	.7my $7K	.6my $7K	To be determined	1980	To be determined

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. Integration of management responsibility at all levels must be achieved consistently throughout this industry. Although there may not be a single optimal management structure for nuclear power plant operation, there must be a single accountable organization with the requisite expertise to take responsibility for the integrated management. (B.3)

2. Although the Commission considers the responsibility for safety to be with the total organization of the plant, we recommend that each nuclear power plant company have a separate safety group that reports to high-level management. Its assignment would be to evaluate regularly procedures and general plant operations from a safety perspective; to assess quality assurance programs; and to develop continuing safety programs. (B.2)

3. Establishment of a single accountable organization with the requisite expertise to take responsibility for the integrated management of the design, construction, operation and emergency response functions and the organizational entities that carry them out. These goals may be obtained at the design stage by 1) contracting for a "turn-key" plant in which the vendor or architect-engineer contracts to supply

a fully operational plant and supervises all planning, construction, and modification; or 2) assembling expertise capable of integrating the design process. In either case, it is critical that the knowledge of expertise gained during design and construction of the plant be effectively transferred to those responsible for operating the plant. (B.3)

4. Clearly defined roles and responsibilities for operating procedures and practices must be established to ensure accountability and smooth communication. (B.3b)

5. Since, under our recommendations, accountability for operations during an emergency would rest on the licensee, the licensee must prepare clear procedures defining management roles and responsibilities in the event of a crises. (B.3c)

6. Responsibility and accountability for safe power plant operations, including the management of a plant during an accident, should be placed on the licensee in all circumstances. It is therefore necessary to assure that licensees are competent to discharge this responsibility. To assure this competency, and in light of our findings regarding Metropolitan Edison, we recommend that the agency establish and enforce higher organizational and management standards for licensees. Particular attention should be given to such matters as the following: integration of decision-making in any organization licensed to construct or operate a plant; kinds of expertise that must be within the organization; financial capability; quality assurance programs; operator and supervisor practices and their periodic reevaluation; plant surveillance and maintenance practices; and requirements for the analysis and reporting of unusual events. (A.5)

7. There should be a program for the systematic assessment of experience in operating reactors, with special emphasis on discovering patterns in abnormal occurrences. An overall quality assurance measurement and reporting system based on this systematic assessment shall be developed to provide:

1) a measure of the overall improvement or decline in safety, and 2) a base for specific programs aimed at curing deficiencies and improving safety. Licensees must receive clear instructions on reporting requirements and clear communications summarizing the lessons of experience at other reactors. (A.11b)

8. There must be a systematic gathering, review, and analysis of operating experience at all nuclear power plants coupled with an industry-wide international communications network to facilitate the speedy flow of this information to affected parties. If such experiences indicate the need for modifications in design or operation, such changes should be implemented according to realistic deadlines. (B.1b)

9. Management of both utilities and suppliers must insist on the early diagnosis and resolution of safety questions that arise in plant operations. They must also establish deadlines, impose sanctions for the failure to observe such deadlines, and make certain that the results of the diagnoses and any proposed procedural changes based on them are disseminated to those who need to know them. (B.5d)

10. The Commission recommends that as a part of the formal safety assurance program, every accident or every new abnormal event be carefully screened, and where appropriate be rigorously investigated, to assess its implications for the existing system design, computer models of the system, equipment design and quality, operations, operator training, operator training simulators, plant procedures, safety systems, emergency measures, management, and regulatory requirements. (D.7)

TMI-2 LESSONS LEARNED TASK FORCE STATUS REPORT AND SHORT-TERM RECOMMENDATIONS (NUREG-0578)

1. Provide on shift at each nuclear power plant a qualified person (the shift technical advisor) with a bachelor's degree or equivalent in a science or engineering discipline and with specific training in the plant response to off-normal events and in accident analysis of the plant. Shift technical advisors shall serve in an advisory capacity to shift supervisors. The licensee shall assign normal duties to the shift technical advisor that pertain to the engineering aspect of assuring safe operations of the plant, including the review and evaluation of operating experience. (2.2.1.b)

TMI-2 LESSONS LEARNED TASK FORCE FINAL REPORT (NUREG-0585)

1. The NRC staff should establish a mechanism whereby individuals committing operational errors are identified in Licensee Event Reports. Such a mechanism should include

provisions for protection of the privacy of the individual. The intent of this recommendation is to provide additional information to operator licensing program personnel to assist them in determining the continued qualification of operators in the review of operator license renewal applications. Due consideration should be given to whether such reporting will affect the quality of reports received by the NRC. (1.4.2)

2. The review and evaluation (being conducted by the Quality Assurance Branch) of the management and technical resources available to utilities who own and operate nuclear power plants to handle unusual events or accidents should contain a requirement for periodic verification of the licensee's technical and management support capability throughout the operating life of the plant. The present criteria for determining the acceptability of licensee technical and management support is very general and applies only to normal plant operations.(1.7)

3. Each licensee should be required to review his procedures for maintenance, test, surveillance and other normal plant operations activities to identify the personnel responsible for conducting the verification. (5.2)

4. Each licensee should be required to review, within 90 days, its administrative procedures to assure that a mechanism exists through which lessons learned from operating experience contained in various publications (such as IE Bulletins, Circulars and Notices, and applicable Licensee Event Reports) and from the licensee's own operating experience evaluation group are conveyed to the reactor operators and other affected operations personnel. Two ways of accomplishing this objective are (1) standard distribution lists or publications and (2) regularly scheduled lectures as part of operations staff retraining. This recommendation is intended to assure that operators and other operations personnel are continually provided with lessons learned from operating experience. (6.2)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (Rogovin)

1. The NRC should satsify itself that every licensee for an operating reactor has evaluated the management and

technical qualifications of its site crews and site management and their familarity with the plant. (p. 146)

2. NRC should require every licensee to hire a cadre of graduate engineers knowledgeable in reactor engineering and physics. Each should be provided with training in the specific characteristics of the plant, with special emphasis on integrated plant response and transient behavior. The utility should be required to deploy at least one such engineer supervisor whose qualifications have been examined by the NRC as shift manager (not as an "advisor") on every shift. (p. 106)

3. A substantially more detailed and upgraded set of requirements should be developed by the NRC for technically competent, NRC-certified, supervisory and management officials to be present on each shift to direct operations. (p. 106)

4. Radiation protection, which has always been secondary in importance to reactor operations and reactor safety, must be given a higher priority. (p. 155)

5. The NRC should give a greater emphasis to radiation protection in both its safety review and inspections. (p. 155)

NRC'S BULLETINS AND ORDERS TASK FORCE RECOMMENDATIONS

1. Operator awareness of revised emergency procedures. (C.3.53)

REPORT OF THE SPECIAL REVIEW GROUP, OFFICE OF INSPECTION AND ENFORCEMENT, NRC (NUREG-0616)

1. Expand IE inspection efforts in the area of instrumentation calibration. Include portable equipment and accident response instrumentation. (2.5.35)

2. IE inspections should concentrate on a comparison of as-built conditions with design criteria and drawings. (2.6.2.3)

Task I.B.2: Inspection of Operating Reactors

The objective is to improve the safety of operations at nuclear powerplants by increasing the effectiveness of the NRC inspection program as follows: (1) revise the existing inspection program, (2) implement the resident inspection program, and (3) systematically assess licensee performance so that NRC may reapportion its resources according to need.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC 1980	NRC 1981	Industry 1980	Industry 1981	Begin	End
1. Revise Inspection and Enforcement Inspection Program	To be scheduled and assigned resources along with normal agency functions.							
2. Resident Inspector at Operating Reactors			.5my $43K 1/134	.5my $90K 1/149	NONE		1980	1980
3. Regional Evaluations	To be scheduled and assigned resources along with normal agency functions.							
4. Overview of Licensee Performance	To be scheduled and assigned resources along with normal agency functions.							

1/Number of inspectors required.

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. The NRC should on a case-by-case basis, before issuing a new construction permit or operating license, review, considering the recommendations set forth in this report, the competency of the prospective operating licensee to manage the plant and the adequacy of its training program for operating personnel. (A.8.b)

2. There should be a program for the systematic assessment of experience in operating reactors, with special emphasis on discovering patterns in abnormal occurrences. An overall quality assurance measurement and reporting system based on this systematic assessment shall be developed to provide: 1) a measure of the overall improvement or decline in safety, and 2) a base for specific programs aimed at curing deficiencies and improving safety. Licensees must receive clear instructions on reporting requirements and clear communications summarizing the lessons of experience at other reactors. (A.11.b)

3. Each operating licensee should be subject periodically to intensive and open review of its performance according to the requirements of its license and applicable regulations. (A.11.e)

4. There must be a systematic gathering, review, and analysis of operating experience at all nuclear power plants coupled with an industry-wide international communications network to facilitate the speedy flow of this information to affected parties. If such experiences indicate the need for modifications in design or operation, such changes should be implemented according to realistic deadlines. (B.1.b)

5. The Commission recommends that as a part of the formal safety assurance program, every accident or every new abnormal event be carefully screened, and where appropriate be rigorously investigated, to assess its implications for the existing system design, computer models of the system, equipment design and quality, operations, operator training, operator training simulators, plant procedures, safety systems, emergency measures, management, and regulatory requirements. (D.7)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. More emphasis should be given to supplementing the resident inspector with a team or "blitz" approach, in which a number of inspectors make unannounced visits from regional headquarters to conduct in-depth inspections of the overall operation of a plant for at least a week or more, perhaps accompanied by the supervisor or by project management personnel.

2. More attention should be given to "reactive" inspections - responding to notifications, complaints, specific problems, or following up on previous difficulties. Better application of risk assessment and improved evaluation of operational data should permit inspection guidelines to be improved and sharpened, so that inspectors' visits can be focused on particular problems anticipated at each plant or with various plant systems. (p. 100)

3. NRC Inspection and Enforcement (IE) should develop new programs to monitor and evaluate utility management and technical competence on an ongoing basis. This will require not only the development of new standards but also acquisition of new skills by NRC to study and evaluate management effectiveness of utilities and to require constructive changes. (p. 100)

4. More effort should be devoted by regional offices to evaluating each utility across-the-board and vis-a-vis other utilities, in order to identify weak spots and problem areas. IE's Performance Evaluation Team (PET), which currently performs this work, should be expanded. (p. 96)

5. Operating information must be evaluated both by industry and the NRC to identify items of potential safety concerns, and these must then be investigated in depth. (p. 97)

Task I.C: Operating Procedures

The objective is to improve the quality of procedures to provide greater assurance that operator and staff actions are technically correct, explicit and easily understood for normal, transient, and accident conditions. The overall content, wording, and format of procedures that affect plant operation, administration, maintenance, testing, and surveillance will be included. A principal part of this work is to improve procedures for dealing with adnormal conditions and emergencies by improving the delineation of symptoms, events, and plant conditions that identify emergency or off-normal situations that confront the operators and, once identified, to assure consistency with operator training.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC		Industry		Begin	End
			1980	1981	1980	1981		
1. Short-Term Accident Analysis and Procedures Revision	1	-	8.6my $67K	10.1my $17K	4.6my per plant	1.0my per plant	1979	1981
2. Shift and Relief Turnover Procedures	1	-	.2my	-	Completed (.1my per plant)		1979	1980
3. Shift Supervisor Responsibilities	1	-	.2my	-	Completed (.1my per plant)		1979	1980
4. Control Room Access	1	-	.2my	-	Completed (.1my per plant)		1979	1980
5. Procedures for Feedback of Operating Experience	1	1	.5my	.1my	.5my per plant	-	1980	1981
6. Procedures for Verification of Correct Performance of Operating Activities	2	-	.2my	.3my	3.5my per reactor		1980	1981
7. Nuclear Steam Supply System Vendor Review of Procedures	1	2	.2my	.3my	$200K per plant		1980	Prior to full power operation
8. Pilot Monitoring of Selected Emergency Procedures for NTOL Applicants	2	3	4.5my $7K	7my	$50K per applicant		Before full power operation	
9. Long-Term Program Plan for Upgrading of Procedures	1	3	1.1my	3.8my	To be determined		1980	1981

RECOMMENDATIONS

TMI-2 LESSONS LEARNED TASK FORCE STATUS REPORT AND SHORT-TERM RECOMMENDATIONS (NUREG-0578)

1. Perform analyses and implement procedures and training for prompt recognition of low reactor coolant level and inadequate core cooling using existing reactor instrumentation (flow, temperature, power, etc.) or short-term modifications of existing instruments. Describe further measures

and provide supporting analyses that will yield more direct indication of low reactor coolant level and inadequate core cooling such as reactor vessel water level instrumentation. (2.1.3b)

2. Provide the analysis, emergency procedures, and training to substantially improve operator performance during a small break loss-of-coolant accident. (2.1.9a)

3. Provide the analysis, emergency procedures, and training needed to assure that the reactor operator can recognize and respond to conditions of inadequate core cooling. (2.1.9b)

4. Provide the analysis, emergency procedures, and training to substantially improve operator performance during transients and accidents, including events that are caused or worsened by inappropriate operator actions. (2.1.9c)

5. Review plant administrative and management procedures. Revise as necessary to assure that reactor operations command and control responsibilities and authority are properly defined. Corporate management shall revise and promptly issue an operations policy directive that emphasizes the duties, responsibilities, and authority and lines of command of the control room operators, the shift technical advisor, and the person responsible for reactor operations command in the control room (i.e., the senior reactor operator). (2.2.1a)

6. Review and revise plant procedures as necessary to assure that a shift turnover checklist is provided and required to be completed and signed by the on-coming and off-going individuals responsible for command of operations in the control room. Supplementary checklists and shift logs should be developed for the entire operations organization, including instrument technicians, auxiliary operators, and maintenance personnel. (2.2.1c)

7. Review plant emergency procedures, and revise as necessary, to assure that access to the control room under normal and accident conditions is limited to those persons necessary to the safe command and control of operations. (2.2.2a)

TMI LESSONS LEARNED TASK FORCE FINAL REPORT (NUREG-0585)

1. Emergency operating procedures for all nuclear power plants should be reviewed by the NRC. The review should be conducted by interdisciplinary review groups comprising I&E inspectors and NRR technical reviewers knowledgeable in system design, accident analysis, operator training, theories

of education and crisis management, human factors, and the underlying technical bases for licensing. Special attention should be paid to the recent advice of the ACRS on the style and content of emergency procedures. A safety evaluation regarding the adequacy of the emergency procedures should be issued at the conlcusion of the review. Previous NRR reviews and I&E reviews of emergency operating procedures did not specifically investigate their compatibility with the design bases of the systems involved nor was the discipline of human factors included.

This action will require a considerable expenditure of resources and its phasing needs to be carefully considered. It may be satisfactory to limit the general application of this recommendation to new operating licenses for the next year or so. These initial few reviews by the staff, with oversight by the ACRS, will provide the time and experience necessary for the staff and industry to develop and agree upon acceptance criteria for the development, formation, and future review of all emergency operating procedures. Upon completion of these acceptance criteria, say within the next two years, a systematic effort by all licensees to review their emergency procedures and revise them as necessary could be conducted more productively than it could today. (4)

2. A more effective system of verifying the correct performance of operating activities is needed to provide a means of reducing human errors and improving the quality of normal operations, thereby reducing the frequency of occurrence of situations that could result in or contribute to accidents. Such a verification system should include automatic system status monitoring and human verification of operations and maintenance activities independent of the people performing the activity.

The Task Force recommends that automatic status monitoring be required by a decision to backfit Regulatory Guide 1.47, "Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems," to plants not already required to meet it. Furthermore, the design to satisfy the objectives of the guide should be flexible and capable of accepting additional monitoring functions at a later date.

The implementation of Regulatory Guide 1.47, although reducing the extent of human verification of operations and maintenance activities, does not eliminate the need for such verification in all instances. Therefore, each licensee should be required to review his procedures for maintenance, test, surveillance and other normal plant operations activities (1) to delineate each activity that requires independent verification because of its importance to safety, (2) to identify the personnel responsible for conducting the verification, and (3) to describe the method of documenting performance of the verification process. The results of this work should be submitted to NRC within six months for use in the development of minimum acceptance criteria for operations verification procedures, probably in the form of a Regulatory Guide. The procedures adopted by the licensees should contain two phases; namely, before and after installation of status monitoring equipment in conformance with Regulatory Guide 1.47. (5)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. We believe the NRC should satisfy itself that every applicant for an OL has evaluated its emergency operator procedures, which should be examined thoroughly to identify whether they may be conflicting or could in some other fashion mislead the operators. Prior to issuing a new OL, the agency should independently assess the utility's readiness in these areas by conducting field inspections to determine whether the applicant's self-examination was adequate in each instance. (p. 146)

NRC'S BULLETINS AND ORDERS TASK FORCE RECOMMENDATIONS

1. Review operating procedures for recognizing, preventing, and mitigating void formation in transients and accidents. (C.1.3)

2. Review operating procedures and training instructions to ensure that:

   (1) Operators do not override ESF actions unless continued operation is unsafe. (C.14a)

   (2) HPI system remains in operation (if actuated automatically) unless

(a) LPI pumps operating at greater than 1000 gpm and situation stable for 20 min;

(b) HPI system operating for 20 min. RCS greater than 50 degrees F subcooled (limited by RV NDT considerations). (C.1.4b)

(3) Until long-term design change requirement of IEB 79-06C is implemented:

(a) Upon reactor trip and HPI initiation caused by RCS law pressure, immediately trip all operating RCPs;

(b) Provide two operators in CR at all times to accomplish RCP trips (three operators for dual CR facility.) (C.1.4c)

(4) Operators are instructed not to rely on level indication alone in evaluating plant conditions. (C.1.4d)

3. Safety-related valve position.

(1) Review all valve positions and positioning requirements and positive controls and all related test and maintenance procedures to assure proper ESF functioning, if required. (C.5a)

(2) Verify that AFW valves are in open position. (C.56)

4. Review and modify (as required) procedures for removing safety-related systems from service (and restoring to service) to assure operability status is known. (C.1.10)

5. Implement (immediately) procedures that identify PRZ PORV "Open" indications and that direct operator to close manually at "RESET" setpoint. (C.1.16)

6. Develop procedures and train operators on methods of establishing and maintaining natural circulation. (C.1.18)

7. Perform LOCA analyses for a range of small-break sizes and a range of time lapses between reactor trip and RCP trip. (C.1.24)

8. Develop operator action guidelines (based on analyses in 7 above). (C.1.25)

9. Revise emergency procedures and train RO's and SRO's based on guidelines developed in 8 above. (C.1.27)

10. Provide analyses and develop guidelines and procedures for inadequate core cooling conditions. Also, define RCP restart criteria. (C.1.27)

11. Small-break LOCA analysis, procedures, and operator training. (C.2.4)

12. Transient analysis and procedures for management of small breaks. (C.2.12)

13. Analysis of potential voiding in RCS during anticipated transients. (C.2.17)

14. Analysis of loss of feedwater and other anticipated transients. (C.2.18)

15. Benchmark analysis of sequential AFW flow to once-through steam generator. (C.2.19)

16. Analysis of system response to small-break LOCA that causes system pressure to exceed PORV setpoint. (C.2.20)

17. Instrumentation to verify natural circulation. (C.3.6)

18. Evaluation of effects of core flood tank injection on small-break LOCAs. (C.3.36)

19. Additional staff audit calculations of B&W small-break LOCA analyses. (C.3.37)

20. Analysis of B&W plant response to isolated small-break LOCA. (C.3.38)

21. Analysis of plant response to a small-break LOCA in the pressurizer spray line. (C.3.39)

22. Evaluation of effects of water slugs in piping caused by HPI and CFT flows. (C.3.40)

23. Submit predictions for LOFT Test L3-6 with RCPs running. (C.3.41)

24. Submit requested information on the effects of non-condensible gases. (C.3.42)

25. Test program for small-break LOCA model verification pretest prediction, test program and model verification. (C.3.48)

26. Review of procedures (NRC). (C.3.50)

27. Review of procedures (NSSS vendors). (C.3.51)

28. Symptom-based emergency procedures. (C.3.52)

29. Operator awareness of revised emergency procedures. (C.3.53)

30. Operator monitoring of control board. (C.3.56)

31. Identify water sources prior to manual activation of ADS. (C.3.58)

Task I.D: Control Room Design

The objective is to improve the ability of nuclear powerplant control room operators to prevent accidents or cope with accidents if they occur by improving the information provided to them.

ACTION ITEMS	PRIORITY		ESTIMATED COST			SCHEDULE	
	NRC's	Industry's	NRC 1980	NRC 1981	Industry 1980 - 1981	Begin	End
1. Control Room Design Reviews	1	2	2.6my $170K	4.1my $270K	$1 - 2M per plant	1980	1982
2. Plant Safety Parameter Display Console	1	2	2my	1.5my $250K	$1 - 2M per plant	1980	1982
3. Safety System Status Monitoring	2	2	-	-	- -	1982 or later	-
4. Control Room Design Standard	1	-	.1my	.6my $5k	To be determined	1980	1983
5. Improved Control Room Instrumentation Research	2	-	1.4my $1.8M	1.7my $2.5M	NONE	1980	1982
6. Technology Transfer Conference	3	-	.2my $45K	-	NONE	Complete	

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. Safety emphasis should include review and approval of control room design; the agency should consider the need for additional instrumentation and for changes in overall design to aid understanding of plant status, particularly for response to emergencies. (A.4.c(ii))

2. Equipment should be reviewed from the point of view of providing information to operators to help them prevent accidents and to cope with accidents when they occur. Included might be instruments that can provide proper warning and diagnostic information; for example, the measurement of the full range of temperatures within the reactor vessel under normal and abnormal conditions, and indication of the actual position of valves. Computer technology should be used for the clear display for operators and shift supervisors of key measurements relevant to accident conditions, together with diagnostic warnings of conditions.

In the interim, consideration should be given to requiring, at TMI and similar plants, the grouping of these key measurements, including distinct warning signals on a single panel available to a specified operator and the providing of a duplicate panel of these key measurements and warnings in the shift supervisor's office. (D.1)

3. Monitoring instruments and recording equipment should be provided to record continuously all critical plant measurements and conditions. (D.3)

TMI-2 LESSONS LEARNED TASK FORCE FINAL REPORT (NUREG-0585)

1. All licensees should be required to conduct a one-year review of their control rooms. The safety review should consider control room design and control room operational procedures, including emergency operating procedures. In this review, the licensees should evaluate:

(1) The adequacy of information presented to the operator to reflect plant status for normal operation, anticipated operational occurrences, and accident conditions;

(2) The grouping of displays and the layout of panels;

(3) Improvements in the safety monitoring and human factors enhancement of controls and control displays;

(4) The communication from the control room to points outside the control room, such as the on-site Technical Support Center. (This communication link must also be coordinated with new requirements for transmission of plant systems data to NRC.);

(5) The use of direct rather than derived signals for the presentation of process and safety information to the operator;

(6) The operability of the plant from the control room with multiple failures of non-safety-grade and non-seismic systems and control room systems;

(7) The adequacy of operating procedures and operator training with respect to limitations of instrumentation displays in the control room;

(8) The categorization of alarms, with unique definition of safety alarms; and

(9) The modification of operating procedures and operator training programs as a function of control room modifications resulting from this review.

The purpose of this recommendation is to improve upon operator-process communications. Guidelines and criteria for the control room design review are now being drafted by the Division of Systems Safety, including consideration of the results of previous studies of this sort and existing technology outside of the nuclear industry. Explicit criteria can probably be developed by about February 1, 1980. Consideration is being given to a series of topical meetings with recognized experts in the field and affected licensees. Specific requirements for backfitting existing control rooms to correct deficiencies will be established in the course of the reviews by licensees. (7.1)

2. Each licensee should be required to define and adequately display in the control room a minimum set of plant parameters (in control terminology, a state vector) that defines the safety status of the nuclear power plant. The minimum set of plant parameters should be annotated for sensor limits, process limits, and sensor status. The annotated set of plant parameters should be presented to the operator in real time by a reliable, single-failure-proof system located in the control room. The annotated set of plant parameters should also be available in real time in the Onsite Technical Support Center.

The objective of this recommendation is to require a concise set of information that is easily available and assessed by the operator and the shift technical advisor to ascertain the safety status of the operating process. The implementation of this recommendation should be undertaken in conjunction with the year-long control room study previously described, but should be completed by January 1, 1981, in consonance with the final implementation date for the onsite technical support center recommended in NUREG-0578. As a further guideline for the development of the safety state vector, the status of the plant process should be designed and instrumented as a function of the various barriers against release of radioactivity. For example, the two primary barriers are the fuel cladding and the reactor coolant pressure boundary. Thus, parameters such as primary liquid inventory and coolant radioactivity levels would be principal components of the state vector for these levels of defense. Similarly, reactor coolant level, containment water level, containment hydrogen content, etc., would be principal components of the state vector for the engineered safety feature levels of defense. (7.2)

3. We recommend that the Office of Nuclear Regulatory Research establish a program to evaluate the safety effectiveness of designs of disturbance analysis systems. This program should consider the evaluation of all pertinent methodologies being used in disturbance analysis systems. The evaluations should be quantitative in nature and include prototype assessments in operating power plant environments. Experience gained in this program should be used to consider whether regulatory requirements should be formulated for the use of disturbance analysis sytems in operating plants. (7.3)

4. The Institute of Electrical and Electronic Engineers (IEEE) has established a standards development committee to define design requirements for the standard control room. The regulatory staff is represented on the committee. We recommend that this standards committee expeditiously complete its work of establishing standard design requirements for future control rooms. The design requirements should consider the lessons learned from the TMI-2 accident as well as the principles of human-factors engineering for the man-machine interface. Upon completion of the standard, the Office of Standards Development should evaluate the standard for its acceptability in the licensing process, including consideration of its partial applicability to plants under construction. (7.5)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. The NRC should develop new standards for instrumentation, computers, print-out devices, CRTs and other digital displays to facilitate information transfer. (p. 127)

2. Every nuclear plant should be required to install the equivalent of a reactimeter that constantly monitors important plant parameters and is tied to an information and display computer that can call up these parameters on an instantaneous or trend basis. This information would also be telemetered to the offsite data center. (p. 127)

3. Disturbance analysis systems should be developed to provide operators a clearer picture of reactor conditions. (p. 127)

4. Using human factors engineering, the NRC should move forward to develop standardized criteria for control room design such as parameters to be displayed, fundamental

grouping of instruments and controls, panel layout, and alarm systems. A deadline for implementation of these requirements related to control room design should be established and enforced. (p. 128)

NRC'S BULLETINS AND ORDERS
TASK FORCE RECOMMENDATIONS

1. Central water level recording. (C.3.23)

2. Operator monitoring of control board. (C.3.56)

Task I.E: Analysis and Dissemination of Operating Experience

The objective is to establish an integrated program, which involves participation by the licensees, vendors, NSAC, INPO, and the NRC and which includes foreign operations experience, for the systematic collection, review, analysis, and feedback of operating experience to NRC licensing, inspection, standards and research activities and to licensees for all NRC-licensed activities. Appropriate corrective action will be taken in response to the feedback.

ACTION ITEMS	PRIORITY		ESTIMATED COST			SCHEDULE	
	NRC's	Industry's	NRC 1980	NRC 1981	Industry 1980 -1981	Begin	End
1. Office for Analysis and Evaluation of Operational Data	1	-	10.2my $230K	22.1my $600K	NONE	1979	1981
2. Program Office Operational Data Activities	1	-	13.5my $100K	20.5my $220K	NONE	1979	1980
3. Operation Safety Data Analysis	1	-	1.1M	1.2M	NONE	1980	-
4. Coordination of Licensee, Industry and Regulatory Programs	1	2	Included with other tasks		$5K per plant	1980	1981
5. Nuclear Plant Reliability Data System	To be scheduled and assigned resources along with normal agency functions						
6. Reporting Requirements	1	1	1.5my $5K	.6my $7K	To be determined	1980	To be determined
7. Foreign Sources	2	-	.6my $65K	1.1my $25K	NONE	1980	1980
8. Human Error Rate Analysis	2	-	.5my $500K	.5my $500K	NONE	1980	1981

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. There should be a program for the systematic assessment of experience in operating reactors, with special emphasis on discovering patterns in abnormal occurrences. An overall quality assurance measurement and reporting system based on this systematic assessment shall be developed to provide: 1) a measure of the overall improvement or decline in safety, and 2) a base for specific programs aimed at curing deficiencies and improving safety. Licensees must receive clear instructions on reporting requirements and clear communications summarizing the lessons of experience at other reactors. (A.11b)

2. There must be a systematic gathering, review, and analysis of operating experience at all nuclear power plants coupled with an industry-wide international communications network to facilitate the speedy flow of this information to affected

parties. If such experiences indicate the need for modifications in design or operation, such changes should be implemented according to realistic deadlines. (B.1b)

3. Management of both utilities and suppliers must insist on the early diagnosis and resolution of safety questions that arise in plant operations. They must also establish deadlines, and make certain that the results of the diagnoses and any proposed procedural changes based on them are disseminated to those who need to know them. (B.5d)

4. The Commission recommends that as a part of the formal safety assurance program, every accident or every new abnormal event be carefully screened, and where appropriate be rigorously investigated, to assess its implications for the existing system design, computer models of the system, equipment design and quality, operations, operator training, operator training simulators, plant procedures, safety systems, emergency measures, management, and regulatory requirements. (D.7)

TMI-2 LESSONS LEARNED TASK FORCE STATUS REPORT AND SHORT-TERM RECOMMENDATIONS (NUREG-0578)

1. Provide on shift at each nuclear power plant a qualified person (the shift technical advisor) with a bachelor's degree or equivalent in a science or engineering discipline and with specific training in the plant response to off-normal events and in accident analysis of the plant. Shift technical advisors shall serve in an advisory capacity to shift supervisors. The licensee shall assign normal duties to the shift technical advisor that pertain to the engineering aspects of assuring safe operations of the plant, including the review and evaluation of operating experience. (2.2.1b)

TMI-2 LESSONS LEARNED TASK FORCE FINAL REPORT (NUREG-0585)

1. An integrated NRC-utility program to evaluate operating experience should be established. Action within the NRC has been initiated to establish an Office of Operational Data Analysis and Evaluation to provide agency-wide coordination and an overview of all operational data analysis-related activities performed within the line offices of NRC. The nuclear industry, through NSAC and INPO, has established

its own operational evaluation program. Pursuant to the recommendations of NUREG-0578, each licensee is now required to have an operations experience evaluation group. The director of the new NRC Office of Operational Data Analysis and Evaluation should take the lead to assure that these diverse programs are formally tied together to the extent necessary to benefit from one anothers' viewpoint and analysis while recognizing their individual responsibilities. (6.1)

2. Each licensee should be required to review, within 90 days, its administrative procedures to assure that a mechanism exists through which lessons learned from operating experience contained in various publications (such as IE Bulletins, Circulars and Notices, and applicable Licensee Event Reports) and from the licensee's own operating experience evaluation group are conveyed to the reactor operators and other affected operations personnel.

Two ways of accomplishing this objective are (1) standard distribution lists or publications and (2) regularly scheduled lectures as part of operations staff retraining. This recommendation is intended to assure that operators and other operations personnel are continually provided with lessons learned from operation experience. (6.2)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. Present NRC staff functions devoted to performing quantitative risk assessment of reactors should be relocated in AEOD. (p. 99)

To aid AEOD, consideration should be given to a revised comprehensive reporting system applicable to both utilities and vendors. This system should require more in-depth reporting and follow-up of significant events, provide for the reporting of minor incidents in a separate format amenable to statistical analysis, and include reporting requirements that are uniform so that the data have a common basis. (p. 99)

NRC'S BULLETINS AND ORDERS TASK FORCE RECOMMENDATIONS

1. One hour notification requirement, and continuous communications channel. (C.1.12)

Task I.F: Quality Assurance

The objective is to be improve the qualifty assurance program for design, construction, and operations to provide greater assurance that plant design, construction, and operational activities are conducted in a manner commensurate with their importance to safety.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC		Industry		Begin	End
			1980	1981	1980	1981		
1. Expand QA list	2	-	-	-	-	-	1983	1983
2. Develop More Detailed Criteria	To be scheduled and assigned resources along with normal agency functions.							

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. Responsibility and accountability for safe power plant operations, including the management of a plant during an accident, should be placed on the licensee in all circumstances. It is therefore necessary to assure that licensees are competent to discharge this responsibility. To assure this competency, and in light of our findings regarding Metropolitan Edison, we recommend that the agency establish and enforce higher organizational and management standards for licensees. Particular attention should be given to such matters as the following: integration of decision-making in any organization licensed to construct or operate a plant; kinds of expertise that must be within the organization; financial capability; quality assurance programs; operator and supervisor practices and their periodic reevaluation; plant surveillance and maintenance practices; and requirements for the analysis and reporting of unusual events. (A.5)

2. The industry should establish a program that specifies appropriate safety standards including those for management, quality assurance, and operating procedures and practices, and that conducts independent evaluations. The recently created Institute of Nuclear Power Operations, or some similar organization, may be an appropriate vehicle for establishing and implementing this program. (B.1a)

3. The agency should be directed to employ a broader definition of matters relating to safety that considers thoroughly the full range of safety matters, including, but not limited to, those now identified as "safety-related" items, which currently receive special attention. (B.4b)

Task I.G: Preoperational and Low-Power Testing

The objective is to increase the capability of the shift crews to operate facilities in a safe and competent manner by assuring that training for plant evolutions and off-normal events is conducted. Near-term operating license facilities will be required to develop and implement intensified training exercises during the low-power testing programs. This may involve the repetition of startup tests on different shifts for training purposes. Based on experiences from the near-term operating license facilities, requirements may be applied to other new facilities or incorporated into the plant drill requirement Review comprehensiveness of test programs.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC		Industry		Begin	End
			1980	1981	1980	1981		
1. Training Requirements	2	2	1.5my	.5my	2my		1980	Prior to full power operation
2. Scope of Test Program	2	-	-	-	-	-	1982 or later	-

RECOMMENDATIONS

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. The NRC should satisfy itself that every licensee for an operating reactor has evaluated their training program for operators. (p. 146)

NRC'S BULLETINS AND ORDERS TASK FORCE RECOMMENDATIONS

1. Review operating procedures and training instructions to ensure that:

    a) Operators do not override ESF actions unless continued operation is unsafe. (C.1.4a)

2. Develop procedures and train operators on methods of establishing and maintaining natural circulation. (C.1.18)

3. Revise emergency procedures and train RO's and SRO's. (C.1.26)

4. Operator training and drilling. (C.2.11)

Task II.A: Siting and Design

The objective is to provide an added contribution to safety through (1) the development of siting criteria for new powerplants, and (2) the re-evaluation with regard to the new siting criteria of facilities either under construction or operating.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC		Industry		Begin	End
			1980	1981	1980	1981		
1. Siting Policy Rulemaking	2	-	7.1my $600K	5.8my $360K	-	-	Draft rule by 10/80	
2. Site Evaluation of Existing Facilities	2	-	1.0my	-	-	-	Commission paper by 10/80	

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. In order to provide an added contribution to safety, the agency should be required, to the maximum extent feasible, to locate new power plants in areas remote from concentrations of population. Siting determinations should be based on technical assessments of various classes of accidents that can take place, including those involving releases of low doses of radiation. (A.6)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. Out of an abundance of caution, future reactors should be located only at sites that are at least 10 miles and perhaps more from any significant center of population. In developing criteria for future siting, we believe the NRC will have to give consideration to the specific characteristics of the area that influence the effectiveness of evacuation: population density; population centers beyond the minimum distance of 10 or more miles from the plant (within which should reside only a relatively small population capable of being quickly evacuated); evacuation routes; and the possibility that land use controls or other measures can be used to maximize the chances that over the lifetime of the reactor large numbers of people are not likely to move into the area near the plant. (p. 130)

2. Specific criteria should be developed promptly by the NRC in conjunction with other Federal and State agencies with experience in emergency evacuations. In this regard, it should be noted that both the Federal Government and the States have substantial land holdings that could provide locations for future remote siting. (p. 131)

Task II.B: Consideration of Degraded or Melted Cores in Safety Review

The objective is to enhance public safety and reduce individual and societal risk by developing and implementing a phased program to include, in safety reviews, consideration of core degradation and melting beyond the design basis. The program phases are (1) short- and medium-term actions for scoping and implementation; (2) added requirements for high population density sites; (3) research programs and design studies to develop additional needed information; and (4) a rulemaking proceeding to establish long-term policy, goals, and requirements related to accidents involving core damage greater than the present design basis.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC 1980	NRC 1981	Industry 1980	Industry 1981	Begin	End
1. Reactor Coolant System Vents	2	-	2.2my $7K	1.2my $75K	0.5my per plant $50 to $100K per plant		1979	1981
2. Plant Shielding to Provide Access to Vital Areas and Protect Safety Equipment for Post-accident Operation	2	-	2my $170K	1.7my $95K	1.0my and $50K per plant		1979	1981
3. Post-accident Sampling	2	-	2my $125K	1.3my $ 95K	1.0my and $100K per plant		1979	1981
4. Training for Mitgating Core Damage	1	1	0.9my -0-	0.3my -0-	1.2my and-$50K		1980	1981
5. Research or Phenomena Associated with Core Degradation and Fuel Melting	2	-	4.5my $8.4M	7.3my $12.9M	-	-	1980	1983
6. Risk Reduction for Operating Reactors at Sites with High Population Densities	1	-	6my $75K	4.6my $150K	Unknown		1980	1980
7. Analysis of Hydrogen Control	1	2	1.4my	-	-	-	1980	1980
8. Rulemaking Proceeding	2	-	3.9my $250K	11.6my $830K	0.5my per plant; 100my industry total		1980	1982

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. The agency should be directed to include, as part of its licensing requirements, plans for the mitigation of the consequences of accidents, including the cleanup and recovery of the contaminated plant. The agency should be directed to review existing licenses and to set deadlines for accomplishing any necessary modifications. (A.7)

2. Because safety measures to afford better protection for the affected population can be drawn from the high standards for plant safety recommended in this report, the

NRC or its successor should, on a case-by-case basis, before issuing a new construction permit or operating license, assess the need to introduce new safety improvements recommended in this report, and in NRC and industry studies. (A.8)

3. Equipment design and maintenance inadequacies noted at TMI should be reviewed from the point of view of mitigating the consequences of accidents. Inadequacies noted in the following should be corrected: iodine filters, the hydrogen recombiner, the vent gas system, containment isolation, reading of water levels in the containment isolation, reading of water levels in the containment area, radiation monitoring in the containment building, and the capability to take and quickly analyze samples of containment atmoshpere and water in various places. (D.2)

4. The Commission recommends that continuing in-depth studies should be initiated on the probabilities and consequences (on-site and off-site) of nuclear power plant accidents, including the consequences of meltdown. (D.4)

TMI-2 LESSONS LEARNED TASK FORCE STATUS REPORT AND SHORT-TERM RECOMMENDATIONS (NUREG-0578)

1. For plants that have external recombiners or purge systems, provide dedicated penetrations and isolation systems that meet the redundancy and single failure requirements of the Commission regulations. Modify design as necessary so that these systems are not connected to, or are branch lines of, the large containment purge penetrations. (2.1.5a)

2. Provide inerting for all Mark I and Mark II BWR containments. This would require changes at Vermont Yankee and Hatch Unit 2 (operating plants), as well as pending OL applications for Mark I and II BWRs. (2.1.5b)

3. A minority of the Task Force recommends that all operating reactors, which do not already have the capability, be required to provide the capability to add, within a few days after an accident, a hydrogen recombiner system for post-accident hydrogen control. (2.1.5c)

4. Perform leakage rate tests on systems outside containment that process primary coolant and could contain high level radioactive materials. Develop and implement a periodic testing program and preventive maintenance programs. (2.1.6a)

5. Perform a design review of the shielding of systems processing primary coolant outside of containment. Determine any areas or equipment that are vital for post-accident occupancy or operation and assure that access and performance will not be unduly impared due to radiation from these systems. (2.1.6b)

6. Provide the analysis, emergency procedures, and training to substantially improve operator performance during a small break loss-of-coolant accident. (2.1.9a)

7. Provide the analysis, emergency procedures, and training to substantially improve operator performance during transients and accidents, including events that are caused or worsened by inappropriate operator actions. (2.1.9c)

TMI-2 LESSONS LEARNED TASK FORCE FINAL REPORT (NUREG-0585)

1. The owners of operating plants and all plants under construction should be required to evaluate the interaction of non-safety and safety-grade systems during normal operation, transients, and design basis accidents to assure that any interaction will not result in exceeding the acceptance criteria for any design basis event. The review should be systematic and include all non-safety components, equipment, systems, and structures under all conditions of normal operation, anticipated operational occurrences, and design basis accidents initiated both within the plant (such as pipe breaks) and from outside the plant (such as earthquakes, other natural phenomena, and offsite hazards). The interactions and effects should consider various failure modes including spurious operation, failure to operate upon demand, and any unusual or erratic operation than might result from exposure to the abnormal process of environmental conditions accompanying the event under study. As a necessary part of this evaluation, proper qualification of safety systems, including mechanical components, should be verified.

The number of simultaneous failures of non-safety equipment considered should reasonably reflect the expected number of non-safety systems simultaneously exposed during the event under study to conditions for which they were not designed or qualified.

Equipment identified as the potential cause of violation of the acceptance criteria for any design basis event should be appropriately modified to eliminate or significantly reduce the probability of the adverse interaction. Alternately, the affected safety systems of structures should be modified to cope with the interaction. The results of the evaluations should be used to review, and modify as appropriate, the plant operating and emergency procedures and operator training. The Task Force recommends that these studies be completed within a year, at which time licensees should submit proposed schedules for making the modifications identified in the evaluations. Completion of this study would not be a condition of licensing new plants in the interim of one year if the basis for continued licensing in face of the present unresolved safety issue on systems interaction is judged by the staff to continue to be valid. (9)

2. The Task Force recommends that the Commission issue within three months a notice of intent to conduct rulemaking to solicit comments on the issues and facts relating to the consideration of design features to mitigate accidents that would result in (a) core-melt and (b) severe core damage, but not substantial melting. Specific areas for comment should include, but not be limited to, the following:

(1) Are design features to mitigate the consequences of either or both of these types of accidents necessary to provide reasonable assurance that the health and safety of the public are protected?

(2) In lieu of such features, should additional and supplemental means of preventing core damage or core-melt accidents, through improved engineered safety features be required?

(3) What should be the objective of such design features? Should the design objectives be a set of specific acceptance criteria (e.g., some limitation on calculated offsite dose) or the reduction of potential offsite exposure that is reasonably achievable?

(4) What should be the characteristics and functions of such design features?

(5) What are the probabilities and consequences of the various event sequences that might result in releasing significant amounts of radioactivity to the environment? Which sequences are amenable to interdiction and by what means?

(6) What is the expected effectiveness and performance of suggested means of reducing the consequences of events in which severe damage or substantial melting of the core occurs, in particular, systems for controlled, filtered venting of the containment and for preventing the uncontrolled combustion of hydrogen?

(7) How should other requirements, and in particular those for siting, emergency plans and procedures, training or other related areas, be modified if such design features were required?

(8) What additional information is required or desirable before setting requirements? What information is available, and what information needs to be developed through experiment, test, analysis, or evaluation?

(9) What should be the final form of the requirement, if any? What should be the implementation schedule for new plants, plants under construction, and operating plants?

The Task Force recommends that a proposed rule be published for public comment within one year of the notice of intent. (10)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. Once the Commission has established criteria that define the level of risk, each site can then be examined to develop a minimum evacuation planning zone, within which evacuation must be capable of being carried out in a safe fashion within the prescribed time period to protect those threatened by a serious accident in a nearby plant. This zone will have to be determined by taking into account the same factors discussed above in connection with siting,

including population density, evacuation routes, prevailing wind patterns, and so on. (p. 133)

2. Where an existing reactor, for example, one located near a large urban area, cannot meet these criteria, logic and prudence dictate that it should be shut down, unless additional safety systems for mitigation of accidents - such as the vented, filtered containment system we discuss later in this report - can be installed either to reduce the area of likely accident consequences or to increase the permissible time for evacuation. (p. 133)

3. We recommend that once criteria for minimum workable evacuation areas are established by the NRC, plants that cannot meet these criteria should be allowed to continue to operate only upon a determination by the President that the temporary continued operation of the plant is certified to be vital to the national interest. (p. 133)

4. Expand the spectrum of design basis accidents used for safety assessment purposes by using operational experience, research results, lessons learned from accidents, and advice from the ACRS, all studied through quantitative risk analysis. Include the affects of multiple equipment and human failures where the risk of occurrence is significantly high. (p. 151)

5. Provide a risk-related scheme for classifying equipment on the basis of safety significance. (p. 151)

6. Modification is definitely needed in the current philosophy that there are some accidents ("Class Nine accidents") so unlikely that reactor designs need not provide for mitigating their consequences. At Three Mile Island, a great deal of radioactive material generated by the damaged core had to be handled by filtering and waste gas systems designed not for an accident but for everyday processing of coolant water containing only small amounts of radioactive materials. Severe damage of the core was supposed to be prevented by engineered safety sytems, and therefore was assumed to be too unlikely to design against. We recommend a thorough review of this approach. Should loss of core damage occur in a nuclear plant, there are certain predictable consequences that might be substantially mitigated, and the risk of severe public health danger thereby substantially reduced, by design improvements of

Task II.C: Reliability Engineering and Risk Assessment

The objective is to improve the system-oriented approaches to safety reviews. In particular, NRC will employ risk assessment methods to identify particularly high-risk accident sequences at individual plants and determine regulatory initiatives to reduce these high-risk sequences. A cadre of experienced practitioners of system reliability and risk assessment methods will be developed in the NRC, its contractors, and in the industry. Also, a library of accident sequence and system reliability models will be developed for application to analysis of operating experience data, research programs, and evaluation of safety versus cost tradeoffs. These will all lead to an improved basis for the licensing review process. Reliability requirements and the single failure criterion will be improved, and requirements for station blackout and "nonsafety" systems important to risk will be developed. Consideration will be given to improving the "systems interaction" issue in regulatory requirements.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
			NRC		Industry			
	NRC's	Industry's	1980	1981	1980	1981	Begin	End
1. Interim Reliability Evaluation Program (IREP)	1	1	11.5my $1.9M	8.5my $1.7M	3my per plant		1980	1981
2. Continuation of IREP	2	1	0.2my -0-	0.1my -0-	-	-	1980	To be determined
3. Systems Interaction	1	-	4.7my $377K	2.8my $12K	-	-	1980	1981
4. Reliability Engineering	2	1	-	-	-	-	1982 or later	Unknown

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. The agency should be directed to employ a broader definition of matters relating to safety that considers thoroughly the full range of safety matters, including, but not limited to, those now identified as "safety-related" items, which currently receive special attention. (A.4b)

2. Other safety emphasis should include:

(i) a systems engineering examination of overall plant design and performance, including interaction among major systems and increased attention to the possibility of multiple failures;

(ii) review and approval of control room design; the agency should consider the need for additional instrumentation and for changes in overall design to aid understanding of plant status, particularly for response to emergencies; and less than staggering cost or complexity. Such improvements should be specifically evaluated in the normal design review basis. (p. 151)

8. In particular, it appears that expedited consideration should be given to the use of vented, filtered containment systems to guard aginst the high-pressure rupture of existing containments, and to the redesign of some of the waste gas and filtering systems that will inevitably be exposed to water and gas coming from the primary system during an accident containing high concentrations of radioactive materials. (p. 151)

NRC'S BULLETINS AND ORDERS TASK FORCE RECOMMENDATIONS

1. Review operating modes and procedures to deal with significant amounts of hydrogen. (C.1.14)

(iii) an increased safety research capacity with a broadly defined scope that includes issues relevant to public health. It is particularly necessary to coordinate research with the regulatory process in an effort to assure the maximum application of scientific knowledge in the nuclear power industry. (A.4c)

3. The Commission recommends that continuing in-depth studies should be initiated on the probabilities and consequences (on-site and off-site) of nuclear power plant accidents, including the consequences of meltdown. (D.4)

TMI-2 LESSONS LEARNED TASK FORCE FINAL REPORT (NUREG-0585)

1. The staff should initiate a systematic assessment of the reliability of safety systems in operating units and in units in the latest stages of construction using simplified fault and event tree analysis. Since these assessments go beyond the requirements of current regulations, their completion should not be a condition of licensing for operation. The purposes of these assessments would be (1) to audit the implementation of the current NRC design requirements by searching for areas that have potential to seriously decrease realiability, and (2) to identify outliers in overall system safety compared with designs previously subjected to this type of review. Measures to correct any problem areas should be promptly referred to the cognizant licensing organization where, in consultation with the Regulatory Requirements Review Committee, backfit decisions are to be promptly reached. If a particular deficiency is identified and known to exist in several systems or plants, appropriate revisions to NRC design requirements should be made with all licensees and applicants being directed to implement the design revisions in their plants. Possible approaches would be to assess all systems in one plant or several systems in all plants. An acceptable combined approach would be to do all systems in a few lead plants and then proceed plant by plant unless particular systems indicated possible generic problems. The suspect systems would then be assessed in all plants, in the manner employed with PWR auxiliary feedwater system in the summer of 1979. This recommendation would apparently be satisfied by the Integrated Reliability Evaluation Program currently under development in the Office of Nuclear Regulatory Research with the previously expressed concurrence of the Office of Nuclear Reactor Regulation. (8)

2. The owners of operating plants and all plants under construction should be required to evaluate the interaction

of non-safety and safety-grade systems during normal operation, transients, and design basis accidents to assure that any interaction will not result in exceeding the acceptance criteria for any design basis event. The review should be systematic and include all non-safety components, equipment, systems, and structures under all conditions of normal operation, anticipated operational occurrences, and design basis accidents initiated both within the plant (such as pipe breaks) and from outside the plant (such as earthquakes, other natural phenomena, and offsite hazards). The interactions and effects should consider various failure modes including spurious operation, failure to operate upon demand, and any unusual or erratic operation that might result from exposure to the abnormal process or environmental conditions accompanying the event under study. As a necessary part of this evaluation, proper qualification of safety systems, including mechanical components, should be verified.

The number of simultaneous failures of non-safety equipment considered should reasonably reflect the expected number of non-safety systems simultaneously exposed during the event under study to conditions for which they were not designed or qualified.

Equipment identified as the potential cause of violation of the acceptance criteria for any design basis event should be appropriately modified to eliminate or significantly reduce the probability of the adverse interaction. Alternately, the affected safety systems or structures should be modified to cope with the interaction. The results of the evaluations should be used to review, and modify as appropriate, the plant operating and emergency procedures and operator training. The Task Force recommends that these studies be completed within a year, at which time licensees should submit proposed schedules for making the modifications identified in the evaluations. Completion of this study would not be a condition of licensing new plants in the interim of one year if the basis for continued licensing in face of the present unresolved safety issue on systems interaction is judged by the staff to continue to be valid. (9)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. The best way to improve the existing design review process is by relying in a major way upon quantitative risk analyses, and by emphasizing those accident sequences that contribute significantly to risk. The design review can then focus on those plant systems that contribute to risk, identify weak points, and upgrade various requirements (maintenance, for example) to eliminate them. (p. 150)

2. The present system has been criticized for relying too heavily on "engineering judgment," which is the term often used to hide an inadequate analytical capability. In our view, there is no way to eliminate such judgments, in part because there will always be judgments that go beyond whatever results are produced by those techniques. What the use of these methods will do is to put the judgments into the safety review process at a better point, judging which accident sequences are important, and why. (p. 150)

3. The current classification of systems and equipment into "safety related" and "nonsafety related" is especially unsatisfactory. The distinction is linked to the design basis accident/single failure approach. Systems or equipment outside the scope of the design basis accident analysis are considered to be not "important to safety" and are not reviewed by NRC to see whether they will perform as intended or meet various dependability criteria. They do not require redundancy. And they do not receive continuing regulatory supervision or surveillance to see that they are properly maintained or that their design is not changed in some way that might interact negatively with other systems. (p. 148)

4. We strongly urge that NRC begin the long and perhaps painful process of converting as much as is feasible of the present review process to a more accident-sequence-oriented approach. (p. 151)

5. A hybrid approach to the transition might be appropriate which includes the following: (1) an expanded spectrum of design basis accidents used for safety assessment purposes by using operational experience, research results, lessons from accidents, and advice from the ACRS, all studied through quantitative risk analysis; (2) the effects of multiple

equipment and human failures, where the risk of occurrence is significantly high; (3) a risk related scheme for classification of equipment on the basis of safety significance; (4) human factors considerations and operational procedures in the review process; and (5) on a selective basis, a determination whether some design features to mitigate the effects of some Class 9 accidents should be required. (p. 151)

6. A thorough review should be made of loss of core cooling and the resultant core damage to determine if certain predictable consequences might be substantially mitigated by design improvements of less than staggering cost or complexity. Such improvements should be specifically evaluated in the noraml design review process. Specific examples are: (1) expedited systems to guard against the high pressure rupture of existing comatinments; and (2) redesign should be undertaken of some of the waste gas and filtering systems that will inevitably be exposed to water and gas coming from the primary system during a major accident. (p. 151)

NRC'S BULLETINS AND ORDERS TASK FORCE RECOMMENDATIONS

1. Review and upgrade reliability and redundancy of non-safety equipment for small-break LOCA mitigation. (C.3.4)

2. Consideration of diverse decay heat removal method for Davis-Besse 1. (C.3.8)

3. Evaluate elimination of PORV function. (C.3.41)

4. Assess change in safety reliability as a result of implementing B&OTF recommendations. (C.3.49)

Task II.D: Reactor Coolant System Relief and Safety Valves

The objective is to demonstrate by testing and analysis that the relief and safety valves, block valves and associated piping in the reactor coolant system are qualified for the full range of operating and accident conditions. Anticipated transients without scram (ATWS) may be considered in later phases of the test program. In addition, design changes or modifications will be made that are necessary to provide positive indication of valve position and automatic closure of the PORV block valve on low pressure in the reactor coolant system.

ACTION ITEMS	PRIORITY		ESTIMATED COST			SCHEDULE	
	NRC's	Industry	NRC 1980	NRC 1981	Industry 1980 - 1981	Begin	End
1. Testing Requirements	1	-	1.0my $260K	0.85my -0-	Included in no. 2	1979	1981
2. Research on Relief and Safety Valve Test Requirements	3	-	0.4my $150K	1.2my $ 1.7M	$5-$10M	1980	1981
3. Relief and Safety Valve Position Indication	1	-	0.1my	0.25my	$100K per plant	Completed	

RECOMMENDATIONS

TMI-2 LESSONS LEARNED TASK FORCE STATUS REPORT AND SHORT-TERM RECOMMENDATIONS (NUREG-0578)

1. Commit to provide performance verification by full scale prototypical testing for all relief and safety valves. Test conditions shall include two-phase slug flow and subcooled liquid flow calculated to occur for design basis transients and accidents. (2.1.2)

NRC'S BULLETINS AND ORDERS TASK FORCE RECOMMENDATIONS

1. Implement (immediately) procedures that identify PRZ PORV "Open" indications and that direct operator to close manually at "RESET" setpoint. (C.1.5)

Task II.E.1: Auxiliary Feedwater System

The objective is to improve the reliability of the auxiliary feedwater system.

ACTION ITEMS	PRIORITY		ESTIMATED COST			SCHEOULE	
	NRC's	Industry's	NRC		Industry	Begin	End
			1980	1981	1980 - 1981		
1. Auxiliary Feedwater System Evaluation	1	1	3.7my $152K	4.4my $112K	$30,000 per plant	1980	1982
2. Auxiliary Feedwater System Automatic Initiation and Flow Indication	1	-	1.5my $80K	1.35my $80K	0.4my and $20K per plant	1977	1981
3. Update Standard Review Plan and Develop Regulatory Guide	To be scheduled and assigned resources along with normal agency functions.						

RECOMMENDATIONS

TMI-2 LESSONS LEARNED TASK FORCE STATUS REPORT AND SHORT-TERM RECOMMENDATIONS (NUREG-0578)

1. Provide automatic initiation of all auxiliary feedwater systems. The initiation signals and circuits shall be designed in such a manner that a single failure will not result in the loss of auxiliary feedwater system function. Testability of the initiating signals and circuits shall be a feature of the design. The initiating signals and circuits shall be powered from the emergency buses. Manual capability to initiate the auxiliary feedwater system from the control room must be retained and must be implemented in such a manner that single failure in the manual circuits will not result in the loss of system function. The a-c motor-driven pumps and valves in the auxiliary feedwater system must be included in the automatic actuation (simultaneous or sequential) of the loads to the emergency buses. The design of the automatic initiating signals and circuits must be such that their failure will not result in the loss of manual capability to initiate the auxiliary feedwater system from the control room. (2.1.7a)

2. Provide safety-grade indication in the control room of auxiliary feedwater flow for each steam generator. The flow instrument channels shall be powered from the emergency buses, consistent with satisfying the power diversity requirements for auxiliary feedwater systems. (2.1.7b)

NRC'S BULLETINS AND ORDERS TASK FORCE RECOMMENDATIONS

1. Implement positive position controls on valves that could compromise or defeat AFW flow. (C.1.7)

2. Immediately implement procedures that assure two independent 100% AFW flow paths, or specify explicitly LCO with reduced AFW capacity. (C.1.7)

3. For facilities with non-automatic AFW initiation, provide dedicated operator in continuous communication with CR to operator AFW. (C.1.15)

4. Upgrade timeliness and reliability of AFW system. (C.2.1)

5. Continued upgrading of AFW system. (C.2.8)

Task II.E.2: Emergency Core Cooling System

The objective is to decrease reliance on the emergency core cooling system (ECCS) for other than loss-of-coolant accidents; ensure that the ECCS design-basis reliability and performance are consistent with operational experience; reach better technical understanding of ECCS performance; and ensure that the uncertainties associated with the prediction of ECCS performance are properly treated in small-break evaluations.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC		Industry		Begin	End
			1980	1981	1980	1981		
1. Reliance on ECCS	2	2	-	-	-	-	1982 or later	Unknown
2. Research on Small Break LOCAs and Anomalous Transients	1	-	8.5my $53.6M	8.5my $46.6M	-	-	1980	1982
3. Uncertainties in Performance Predictions	2	2	$800K	-	-	-	1982 or later	Unknown

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. The Commission recommends that continuing in-depth studies should be initiated on the probabilities and consequences (on-site and off-site) of nuclear power plant accidents, including the consequences of meltdown. (D.4)

TMI-2 LESSONS LEARNED TASK FORCE STATUS REPORT AND SHORT-TERM RECOMMENDATIONS (NUREG 0578)

1. Provide redundant emergency power for the minimum number of pressurizer heaters required to maintain natural circulation conditions in the event of loss of off-site power. Also provide emergency power to the control and motive power systems for the power-operated relief valves amd associated block valves and to the pressurizer level indication instrument channels. (2.1.1)

NRC'S BULLETINS AND ORDERS TASK FORCE RECOMMENDATIONS

1. Study effect on RHR reliability of its use for fuel pool cooling. (C.3.26)

2. RELAP-4 model development (C.3.42)

3. Test program for small-break LOCA model verification pretest prediction, test program and model verification. (C.3.48)

Task II.E.3: Decay Heat Removal

The objective is to improve the reliability and capability of nuclear power-plant systems for removing decay heat and achieving safe shutdown conditions following transients and under post-accident conditions.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC		Industry		Begin	End
			1980	1981	1980	1981		
1. Reliability of Power Supplies for Natural Circulation	1	-	0.2my	0.2my	1my & $100K per plant	1my & 25K per plant	1979	1980
2. Systems Reliability	1	-	0.3my	0.4my $75K	-	-	1980	1982
3. Coordinated Study of Shutdown Heat Removal Requirements	2	-	0.1	-	-	-	1980	1981
4. Alternate Concepts Research	To be scheduled and assigned resources along with normal agency functions.							
5. Regulatory Guide	To be scheduled and assigned resources along with normal agency functions.							

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. The Commission recommends that continuing in-depth studies should be initiated on the probabilities and consequences (on-site and off-site) of nuclear power plant accidents, including the consequences of meltdown. (D.4)

TMI-2 LESSONS LEARNED TASK FORCE STATUS REPORT AND SHORT-TERM RECOMMENDATIONS (NUREG 0578)

1. Provide redundant emergency power for the minimum number of pressurizer heaters required to maintain natural circulation conditions in the event of loss of off-site power. Also provide emergency power to the control and motive power systems for the power-operated relief valves amd associated block valves and to the pressurizer level indication instrument channels. (2.1.1)

NRC'S BULLETINS AND ORDERS TASK FORCE RECOMMENDATIONS

1. Study effect on RHR reliability of its use for fuel pool cooling. (C.3.26)

2. RELAP-4 model development (C.3.42)

3. Test program for small-break LOCA model verification pretest prediction, test program and model verification. (C.3.48)

Task II.E.4: Containment Design

The objective is to improve the reliability and capability of nuclear power-plant containment structures to reduce the radiological consequences and risk to the public from design basis events and degraded-core and core-melt accidents.

ACTION ITEMS	PRIORITY		ESTIMATED COST			SCHEDULE	
	NRC's	Industry's	NRC 1980 -	NRC 1981	Industry 1980 - 1981	Begin	End
1. Dedicated Penetrations	1	-	.75my	.95my	.2my per reactor	1979	1981
2. Isolation Dependability	1	-	2.7my $5K	1.75my $5K	1my plus $350K per plant	1979	1981
3. Integrity Check	2	3	-	-	To be determined	1982 or later	To be determined
4. Purging	1	1	.5my $50K	1my $50K	Unknown	1979	1982

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. Equipment design and maintenance inadequacies noted at TMI should be reviewed from the point of view of mitigating the consequences of accidents. Inadequacies noted in the following should be corrected: iodine filters, the hydrogen recombiner, the vent gas system, containment isolation, reading of water levels in the containment isolation, reading of water levels in the containment area, radiation monitoring in the containment building, and the capability to take and quickly analyze samples of containment atmosphere and water in various places. (D.2)

2. The Commission recommends that continuing in-depth studies should be initiated on the probabilities and consequences (on-site and off-site) of nuclear power plant accidents, including the consequences of meltdown. (D.4)

TMI-2 LESSONS LEARNED TASK FORCE STATUS REPORT AND SHORT-TERM RECOMMENDATIONS (NUREG-0578)

1. Provide inerting for all Mark I and Mark II BWR containments. This would require changes at Vermont Yankee and Hatch Unit 2 (operating plants), as well as pending OL applications for Mark I and II BWRs. (2.1.5a)

2. For plants that have external recombiners or purge systems, provide dedicated penetrations and isolation systems that meet the redundancy and single failure

requirements of the Commission regulations. Modify design as necessary so that these systems are not connected to, or are branch lines of, the large containment purge penetrations. (2.5.5b)

3. A minority of the Task Force recommends that all operating reactors, which do not already have the capability, be required to provide the capability to add, within a few days after an accident, a hydrogen recombiner system for post-accident hydrogen control. (2.1.5c)

NRC'S BULLETINS AND ORDERS TASK FORCE RECOMMENDATIONS

1. Review containment isolation initiation design and procedures. Assure isolation of all lines that do not degrade safety features or cooling capability upon automatic initiation of SI. (C.1.6)

2. Review procedures to assure that radioactive liquids and gases are not transferred out of containment inadvertently (especially upon ESF reset). List all applicable systems and interlocks. (C.1.9)

3. Review operating modes and procedures to deal with significant amounts of hydrogen. (C.1.14)

Task II.E.5: Design Sensitivity of B&W Reactor

The objective is to reduce the sensitivity of B&W plants to feedwater transients, with emphasis on the overcooling transients that have been observed at B&W operating plants.

ACTION ITEMS	PRIORITY		ESTIMATED COST		SCHEDULE	
	NRC's	Industry's	NRC 1980 - 1981	Industry 1980 - 1981	Begin	End
1. Design Evaluation	2	-	2.5my - $200K	5.5my per plant. Capital costs unknown.	1979	To be determined
2. B&W Reactor Transient Response Task Force	2	-	Resources included in above task.	NONE	1980	1980

RECOMMENDATIONS

NRC'S BULLETINS AND ORDERS TASK FORCE RECOMMENDATIONS

1. Describe design and procedure modifications (based on analysis) to reduce likelihood of automatic PZR POVR actuation in transients. (C.1.19)

Task II.E.6: In-Situ Testing of Valves

The objective is to evaluate whether current requirements for valve testing provide adequate assurance of performance under design conditions.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC		Industry		Begin	End
			1980	1981	1980	1981		
1. Test Adequacy Study	To be scheduled and assigned resources along with normal agency functions.							

Task II.F: Instrumentation and Control

The objective is to provide instrumentation to monitor plant variables and systems during and following an accident. Indications of plant variables and status of systems important to safety are required by the plant operator (licensee) during accident situations to (1) provide information needed to permit the operator to take preplanned manual actions to accomplish safe plant shutdown; (2) determine whether the reactor trip, engineered safety features systems, and manually initiated systems are performing their intended functions (i.e., reactivity control, core cooling, maintaining reactor coolant system integrity, and maintaining containment integrity); (3) provide information to the operator that will enable him to determine the potential for causing a breach of the barriers to radioactivity release (i.e., fuel cladding, reactor coolant pressure boundary, and containment) and if a barrier has been breached; (4) furnish data for deciding on the need to take unplanned action if an automatic or manually initiated safety system is not functioning properly or the plant is not responding properly to the safety systems in operation; and (5) allow for early indication of the need to initiate action necessary to protect the public and for an estimate of the magnitude of the impending threat.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC		Industry		Begin	End
			1980	1981	1900	1981		
1. Additional Accident Monitoring Instrumentation	1	-	1.8my $130K	2my $100K	$250K per reactor	-	1979	1981
2. Identification of and Recovery from Conditions Leading to Inadequate Core Cooling	1	-	2.5my $100K	1.65mu $100K	1.0my and 250K per reactor	-	1979	1981
3. Regulatory Guide 1.97	2	2	1.1my	2.6my	Up to $6M per plant		1979	1982
4. Study of Control and Protection Action Design Requirements	3	To be scheduled and assigned resources along with normal agency functions.						
5. Classification of instrumentation, control, and electrical equipment	2	0	.4my	1my	NONE		1980	

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. Equipment design and maintenance inadequacies noted at TMI should be reviewed from the point of view of mitigating the consequences of accidents. Inadequacies noted in the following should be corrected: iodine filters, the hydrogen recombiner, the vent gas system, containment isolation, reading of water levels in the containment isolation, reading of water levels in the containment area, radiation monitoring in the containment building, and the capability to take and quickly analyze samples of containment atmosphere and water in various places. (D.2)

2. Monitoring instruments and recording equipment should be provided to record continuously all critical plant measurements and conditions. (D.3)

3. Radiation monitors should be available for monitoring of routine operations as well as accident levels. (E.4a)

TMI-2 LESSONS LEARNED TASK FORCE STATUS REPORT AND SHORT-TERM RECOMMENDATIONS (NUREG-0578)

1. Provide in the control room either a reliable, direct position indication for the valves or a reliable flow indication devices downstream of the valves. (2.1.3a)

2. Perform analyses and implement procedures and training for prompt recognition of low reactor coolant level and inadequate core cooling using existing reactor instrumentation (flow, temperature, power, etc.) or short-term modifications of existing instruments. Describe further measures and provide supporting analyses that will yield more direct indication of low reactor coolant level and inadequate core cooling such as reactor vessel water level instrumentation. (2.1.3b)

3. Provide safety-grade indication in the control room of auxiliary feedwater flow for each steam generator. The flow instrument channels shall be powered from the emergency buses, consistent with satisfying the power diversity requirements for auxiliary feedwater systems. (2.1.7b)

4. Review and upgrade the capability to obtain samples from the reactor coolant system and containment atmosphere under high radioactivity conditions. Provide the capability for chemical and spectrum analysis of high-level samples on site. (2.1.8a)

5. Provide high range radiation monitors for noble gases in plant effluent lines and a high-range radiation monitor in the containment. Provide instrumentation for monitoring effluent release lines capable of measuring and identifying radioiodine and particulate radioactive effluents under accident conditions. (2.1.8b)

TMI-2 LESSONS LEARNED TASK FORCE FINAL REPORT (NUREG 0585)

1. A more effective system of verifying the correct performance of operating activities is needed to provide a means of reducing human errors and improving the quality

of normal operations, thereby reducing the frequency of occurrence of situations that could result in or contribute to accidents. Such a verification system should include automatic system status monitoring and human verification of operations and maintenance activities independent of the people performing the activity.

The Task Force recommends that automatic status monitoring be required by a decision to backfit Regulatory Guide 1.47, "Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems," to plants not already required to meet it. Furthermore, the design to satisfy the objectives of the guide should be flexible and capable of accepting additional monitoring functions at a later date.

The implementation of Regulatory Guide 1.47, although reducing the extent of human verification of operations and maintenance activities, does not eliminate the need for such verification in all instances. Therefore, each licensee should be required to review his procedures for maintenance, test, surveillance and other normal plant operations activities (1) to delineate each activity that requires independent verification because of its importance to safety, (2) to identify the personnel responsible for conducting the verification, and (3) to describe the method of documenting performance of the verification process. The results of this work should be submitted to NRC within six months for use in the development of minimum acceptance criteria for operations verification procedures, probably in the form of a Regulatory Guide. The procedures adopted by the licensee should contain two phases; namely, before and after installation of status monitoring equipment in conformance with Regulatory Guide 1.47.(5)

NRC'S BULLETINS AND ORDERS TASK FORCE RECOMMENDATIONS

1. Operators are instructed not to rely on level indication alone in evaluating plant conditions. (C.14d)

2. Review operating modes and procedures to deal with significant amounts of hydrogen. (C.1.14)

3. Describe uses and types of RV level indication for automatic and manual initiation safety systems. Also, describe alternative instrumentation. (C.1.23)

4. Provide analyses and develop guidelines and procedures for inadequate core cooling conditions. Also, define RCP restart criteria. (C.1.27)

5. Instrumentation to verify natural circulation. (C.3.6)

Task II.G: Electrical Power

The objective is to increase the reliability and diversification of the electrical power supplies for certain safety related equipment.

ACTION ITEMS	PRIORITY		ESTIMATED COST			SCHEDULE	
	NRC's	Industry's	NRC		Industry	Begin	End
			1980	1981	1980 - 1981		
1. Power Supplies for Pressurizer Relief Valves, Block Valves and Level Indications	1	-	1my	.2my	$350K for plants more than 50% built	1979	1981

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. Equipment design and maintenance inadequacies noted at TMI should be reviewed from the point of view of mitigating the consequences of accidents. Inadequacies noted in the following should be corrected: iodine filters, the hydrogen recombiner, the vent gas system, containment isolation, reading of water levels in the containment isolation, reading of water levels in the containment area, radiation monitoring in the containment building, and the capability to take and quickly analyze samples of containment atmosphere and water in various places. (D.2)

TMI-2 LESSONS LEARNED TASK FORCE STATUS REPORT AND SHORT-TERM RECOMMENDATIONS (NUREG-0578)

1. Provide redundant emergency power for the minimum number of pressurizer heaters required to maintain natural circulation conditions in the event of loss of offsite power. Also provide emergency power to the control and motive power systems for the power-operated relief valves and associated block valves and to the pressurizer level indication instrument channels. (2.1.1)

Task II.H: TMI-2 Cleanup and Examination

The objective is to maintain safety and minimize environmental impact of post-accident operation and cleanup of TMI-2; obtain and factor into regulatory programs safety-related and environmental information from the TMI-2 cleanup.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC		Industry		Begin	End
			1980	1981	1980	1981		
1. Maintain Safety of TMI-2 and Minimize Environmental Impact	1	-	13.6my $1.5M	19.4my $1.6M	$300M-- TMI-2 only		1980	1984
2. Obtain Technical Data on the Conditions Inside the TMI-2 Containment Structure	2	-	.5my $525K	1.9my $1.2M	-	-	1979	1984
3. Evaluate and Feedback Information Obtained form TMI	2	-	Included in item 2 above		NONE		1981	1984
4. Determine Impact of TMI on Socioeconomic and Real Property Values	3	-	.2my $70K	.1my	NONE		1979	1981

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. The agency should be directed to include, as part of its licensing requirements, plans for the mitigation of the consequences of accidents, including the cleanup and recovery of the contaminated plant. The agency should be directed to review existing licenses and to set deadlines for accomplishing any necessary modifications. (A.7)

2. The Commission recommends that continuing in-depth studies should be initiated on the probabilities and consequences (on-site and off-site) of nuclear power plant accidents, including the consequences of meltdown. Results of these studies should be used to help plan for recovery and cleanup following a major accident. (D.4b)

3. Since there are still health hazards associated with the cleanup and disposal process, which is being carried out for the first time in a commercial nuclear power plant, the Commission recommends close monitoring of the cleanup process at TMI and of the transportation and disposal of the large amount of radioactive material. As much data as possible should be preserved and recorded about the conditions within the containment building so that these may be used for future safety analyses. (D.6)

Task II.J.1: Vendor Inspection Program

The objective is to improve vendor-supplied components and service through a modified and more effective vendor inspection program.

ACTION ITEMS	PRIORITY		ESTIMATED COST		SCHEDULE	
	NRC's	Industry's	NRC 1980 - 1981	Industry 1980 - 1981	Begin	End
1. Establish a Priority System for Conducting Vendor Inspections	To be scheduled and assigned resources along with normal agency functions.					
2. Modify Existing Vendor Inspection Program	To be scheduled and assigned resources along with normal agency functions.					
3. Increase Regulatory Control Over Present Nonlicenses	To be scheduled and assigned resources along with normal agency functions.					
4. Assign Resident Inspectors to Reactor Vendors and Architect-Engineers	To be scheduled and assigned resources along with normal agency functions.					

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. The agency's inspection and enforcement functions must receive increased emphasis and improved management, including the following elements. (A.11)

2. The Commission recommends that as a part of the formal safety assurance program, every accident or every new abnormal event be carefully screened, and where appropriate be rigorously investigated, to assess its implications for the existing system design, computer models of the system, equipment design and quality, operations, operator training, operator training simulators, plant procedures, safety systems, emergency measures, management, and regulatory requirements. (D.7)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. An immediate, substantial shift in the balance of existing resources in the NRC from design review to the monitoring of operating reactors, and consolidation of these resources in one NRC office; new mechanisms to evaluate operating experience and to ensure that necessary changes are implemented in the regulatory program; and an improved inspection and evaluation system for operating reactors. (p. 90)

2. We found that in the past the NRC and the industry have done almost nothing to evaluate systematically the operation of existing reactors, pinpoint potential safety problems, and eliminate them by requiring changes in design, operator procedures, or control logic. The lack of any such comprehensive program constitutes, in our view, an unacceptable situation that compromises safety and that cannot be allowed to continue. (p. 95)

3. We found a great deal of variation in the extent to which they monitor at their own expense operating problems in the plants they have built, after those plants are tested and turned over to the utilities that have purchased them. And the relationship between the vendor and its utility customer after operation of a plant begins is largely determined by the individual utility's choice of how much technical assistance it is willing to buy from the vendor on an ongoing, contract basis. (p. 96)

Task II.J.2: Construction Inspection Program

The objective is to provide greater assurance that nuclear powerplants are properly constructed by improving construction inspection program.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC		Industry		Begin	End
			1980	1981	1980	1981		
1. Reorient Inspection Program More Toward Direct Observation, Proper Work Performance, and Verification of as-built Configurations Versus Design	3	-	1.0my	.5my	NONE		1980	1981
2. Increase Emphasis on Independent Measurement in the Construction Inspection Program	3	-	.2my	-	NONE		1980	1980
3. Assign Resident Inspectors to all Construction Sites	To be scheduled and assigned resources along with normal agency functions.							

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. The agency should be directed to require its enforcement personnel to perform improved inspection and auditing of licensee compliance with regulations and to conduct major and unannounced on-site inspections of particular plants. (A.11d)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. The separation of licensing into two stages, a CP and an OL, also frustrates effective challenge to design features of a plant from outside the NRC staff, and to some extent from the staff as well. At the CP stage only rough design plans are furnished. By the time the utility submits an application for an OL, the plant may be substantially constructed, and systems are either in place or committed to. Thus, one lengthy safety review is conducted too early to be useful, and the other is too late to be fully effective. In between times, the sketchiness of the original design makes the task of the Office of Inspection and Enforcement that much more difficult during the construction period. (p. 139)

REPORT OF THE SPECIAL REVIEW GROUP, OFFICE OF INSPECTION AND ENFORCEMENT, NRC (NUREG-0616)

1. The Office of Inspection and Enforcement should take additional action to emphasize observation of work activities. (2.2.1.1)

2. Action should be taken to ensure trained inspector access to licensee facilities with minimum delay. (2.2.1.2)

3. For major outages the IE inspection program should be revised to require and IE/licensee management meeting to review outage accomplsihments, major modifications, systems status, and other significant conditions before return to power. (2.2.1.3)

4. The IE inspection program should be revised to incorporate provisions for review of major outage schedules as a basis of inspection planning. (2.2.1.4)

5. The IE inspection program should place additional emphasis on outage control and require IE to observe a larger portion of plant modifications and changes. Team inspections by regional inspectors during outages should complement the resident inspector's activities. (2.2.1.5)

6. An expansion of independent assessment with adequate planning, direction, management and guidance should be undertaken. The correct ratio of IE to contractor resources should be established and procedures developed. A dedicated task group with actual power plant experience in diverse areas such as calibration, NDE, and HP should be created to oversee development of this program. (2.2.2)

7. Regional line level management should be more actively involved in the supervision of inspectors at the site. This will involve consideration of what constitutes adequate supervision and what is the function of the Section Chief. (2.2.3.1)

8. Project and resident inspectors should be required to perform a project status review periodically with inspectors who have conducted inspections at the site to integrate findings. (2.2.3.2)

9. The current regional organization relative to the reactor inspection program should be reviewed to identify changes required to implement the resident program. The use of inspector resources (e.g. project, resident, specialist) should be examined with the goal of establishing as uniform regional organization as is practical. (2.2.3.4)

10. A group of inspection specialists should develop specific IE inspection guidance to review licensee actions related to NUREG-0578. (2.2.3.5)

11. An independent IE organization should periodically audit regional implementation of the IE inspection program, to verify consistency and conformance with established IE policy. This independent audit group should report directly to the Director, Office of Inspection and Enforcement. (2.2.3.6)

12. IE review of the technical adequacy of licensee procedures should be significantly improved. Step-by-step evaluation of adequacy including correlation with the as-built system should be done for important procedures. Inspection guidance should be issued regarding number (fraction) and type of procedures which should be given this depth of review. Inspector resources needed to accomplish the program should be obtained. (2.2.4)

13. Interdisciplinary teams from IE and other NRC offices should perform frequent audits of licensee and licensee contractor design controls. Architect engineers and nuclear steam system suppliers should be brought under NRC regulatory authority. (2.6.2.1)

14. The IE inspection program should be strengthened by including specific requirements to audit design changes in the field during construction and preoperational testing. (2.6.2.2)

15. IE inspections should concentrate on a comparison of as-built conditions with design criteria and drawings. (2.6.2.3)

16. NRC should reevaluate the concept of shared systems between dual units. Systems shared between units should be subject to more in-depth design verification in the design phase, due to the probability of interaction. (2.6.3.1)

17. Revise the construction inspection program to enlarge the sample of components reviewed for qualification. Consideration should be given to establishing an IE HQ environmental qualification review group similar to the Seismic Qualification Review Group to perform reviews which would include components from all systems categories. (2.6.3.2)

18. Establish a data bank of qualification reports by report number, vendor, and component. (2.6.3.3)

19. Revise the IE inspection program to include positive requirements and criteria for evaluating and determining acceptability of environmental qualification reports for components and systems and qualification of testing laboratories. (2.6.2.4)

20. Initiate a study by IE and NRR to evaluate the need for a continuing program of testing at nuclear power plants to confirm that plant behavior later in plant life continues as expected. (2.6.2.5)

21. Resident inspectors assigned to sites which are in the preoperational and startup phases should be supplemented by a preoperational inspection team leader from the regional office. The team leader, who would also serve as a backup resident inspector would plan and direct the preoperational inspection program from the regional office. Site coordination would be the responsibility of the resident. (2.2.3.3)

Task II.J.3: Management for Design and Construction

The objective is to improve the qualification of licensees for operating nuclear powerplants by requiring greater oversight of design, construction, and modification activities.

ACTION ITEMS	PRIORITY		ESTIMATED COST			SCHEDULE	
	NRC's	Industry's	NRC 1980 - 1981		Industry 1980 - 1981	Begin	End
1. Organization and Staffing to Oversee Design and Construction	1	3	.5my		Included in task I.B.1.1.	1979	1982
2. Issue Regulatory Guide	3	-	.3my	.6my $5K	NONE	1980	1981

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. There must be a single accountable organization with the requisite expertise to take responsibility for the integrated management of the design, construction, operation, and emergency response functions, and the organizational entities that carry them out. These goals may be obtained at the design stage by 1) contracting for a "turn-key" plant in which the vendor or architect-engineer contracts to supply a fully operational plant and supervises all planning, construction, and modification; or 2) assembling expertise capable of integrating the design process. In either case, it is critical that the knowledge and expertise gained during design and construction of the plant be effectively transferred to those responsible for operating the plant. (B.3a)

Task II.J.4: Revise Deficiency Reporting Requirements

The objective is to clarify construction and non-licensee reporting requirements to obtain uniform reporting and earlier identification and correction of problems.

ACTION ITEMS	PRIORITY		ESTIMATED COST			SCHEDU	
	NRC's	Industry's	NRC		Industry	Begin	
			1980	1981	1980- 1981		
1. Revise Construction and Nonlicensee Deficiency Reporting Requirements	1	-	.1my	.8my	12my per plant	1980	E

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. The agency's inspection and enforcement functions mu receive increased emphasis and improved management. (A.11

Task II.K: Measures to Mitigate Small-Break Loss-of-Coolant Accidents and Loss of Feedwater Accidents

The objective is to perform systems reliability analysis and to effect changes in emergency operating procedures and operator training to improve the capability of plants to mitigate the consequences of the small-break loss-of-coolant accidents (LOCA) and loss of feedwater events.

ACTION ITEMS	PRIORITY		ESTIMATED COST			SCHEDULE	
	NRC's	Industry's	NRC 1980	NRC 1981	Industry 1980 - 1981	Begin	End
1. IE Bulletins	1	1	.1my	.8my	.2my per application	1980	Prior to fuel loading
2. Commission Orders on B&W Plants	1	-	2my	2.5my	1my per plant	1979	1981
3. Final Recommendations of B&O Task Force	1	-	7.7my	11.2my	2my per plant	1980	1983

RECOMMENDATIONS

NRC'S BULLETINS AND ORDERS TASK FORCE RECOMMENDATIONS

1. Propose Technical Specification changes reflecting implementation of all Bulletin items, as required. (C.1.13)

2. Trip PZR Level Bistable so the PZR Lo Pressure (rather than PZR Lo Pressure and PZR Lo Level coincidence) will trip reactor. For test, reset Lo Level bistable. (C.1.17)

3. Provide procedures and training to operators for prompt manual reactor trip for LOFW, TT, MSIV closure, LOOP, LOSG Level, & Lo PZR Level. (C.1.20)

4. Provide automatic safety-grade anticipatory reactor trip for LOFW, TT or significant decrease in SG level. (C.1.21)

5. Describe automatic and manual actions for proper functioning of auxiliary heat removal system when MFW system not operable. (C.1.22)

6. Describe uses and types of RV level indication for automatic and manual initiation safety systems. Also, describe alternative instrumentation. (C.1.23)

7. Provide design that will assure automatic RCP trip for all circumstances where required. (C.1.28)

8. Procedures and training to initiate and control AFW independent of integrated control system. C.2.2)

9. Hard-wired control-grade anticipatory reactor trips. (C.2.3)

10. Reevaluate analysis for dual-level setpoint control. (C.2.6)

11. Reevaluate transient of September 24, 1977. (C.2.7)

12. Analysis and upgrading of integrated control system. (C.2.9)

13. Hard-wired safety-grade anticipatory reactor trips. (C.2.10)

14. Thermal-mechanical report -- effect of HPI on vessel integrity for small-break LOCA with no AFW. (C.2.13)

15. Demonstrate that predicted lift frequency of PORVs and SVs is acceptable. (C.2.14)

16. Analysis of effects of slug flow on once-through stear generator tubes after primary system voiding. (C.2.15)

17. Impact of RCP seal damage following small-break LOCA with loss of offsite power. (C.2.16)

18. Install automatic PORV isolation system and perform operational test. (C.3.1)

19. Report on overall safety effect of PORV isolation system. (C.3.2)

20. Report safety and relief valve failures promptly and challenges annually. (C.3.3)

21. Install automatic trip of RCPs during LOCA. (C.3.5)

22. Pressure Integral Derivative controller modification. (C.3.9)

23. Anticipatory trip modification proposed by some licensees to confine range of use to high power levels. (C.3.10)

24. Control use of PORV supplied by Control Components Inc. until further review complete. (C.3.11)

25. Confirm existence of anticipatory trip upon turbine trip. (C.3.12)

26. Separation of HPCI and RCIC system initiation levels. Analysis and implementation. (C.3.13)

27. Isolation of isolation condensers on high radiation. (C.2.14)

28. Modify break detection logic to prevent spurious isolation of HPCI and RCIC systems. (C.3.15)

29. Reduction of challenges and failures of relief valves - feasibility study and system modification. (C.3.16)

30. Report on outage of ECC systems - licensee report and proposed technical specification changes. (C.3.17)

31. Modification of ADS logic - feasibility study and modification for increased diversity for same event sequences. (C.3.18)

32. Interlock on recirculation pump loops. (C.3.19)

33. Loss of service water for Big Rock Point. (C.3.20)

34. Restart of core spray and LPCI systems on low level - design and modification. (C.3.21)

35. Automatic switchover of RCIC system suction - verify procedures and modify design. (C.3.22)

36. Confirm adequacy of space cooling for HPCI and RCIC systems. (C.3.24)

37. Effect of loss of AC power on pump seals. (C.3.25)

38. Provide common reference level for vessel level instrumentation. (C.3.27)

39. Study and verify qualification of accumulators on ADS valves. (C.3.28)

40. Provide diverse initiation signal for RCIC system is used for LOCA. (C.3.29)

41. Study to demonstrate performance of isolation condensers with non-condensibles. (C.3.30)

42. Revised small-break LOCA methods to show compliance with 10 CFR 50, Appendix K. (C.3.31)

43. Plant-specific calculations to show compliance with 10 CFR 50.46. (C.3.32)

44. Provide experimental verification of two-phase natural circulation models. (C.3.33)

45. Evaluation of RCP seal damage and leakage during a small-break LOCA. (C.3.41)

46. Evaluation of mechanical effects of slug flow on steam generator tubes. (C.3.44)

47. Evaluation of anticipated transients with single failure to verify no fuel failure. (C.3.45)

48. Evaluate depressurization with other than ADS. (C.3.46)

49. Response to list of concerns from ACRS consultant. (C.3.47)

Task III.A.1: Improve Licensee Emergency Preparedness-Short Term

The objective is to immediately improve and upgrade licensee emergency preparedness by requiring improvements in facilities, plans, procedures, off-site support, technical assistance, equipment and supplies required to adequately respond to and manage an accident.

ACTION ITEMS	PRIORITY		ESTIMATED COST			SCHEDULE	
	NRC's	Industry's	NRC 1980	NRC 1981	Industry 1980 - 1981	Begin	End
1. Upgrade Emergency Preparedness	1	-	29my $1.5M	43my $1.7M	Included below	1979	1981
2. Upgrade License Emergency Support Facilities	1	-	Included in above		$4.8-$11.4M	1979	1980
3. Maintain Supplies of Thyroid Blocking Agent (Potassium Iodine)	3	2	Included in above		0.2my/plant $5K/plant (workers only)	1980 (Workers only)	1981

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. The emergency control center for health-physics operations and the analytical laboratory to be used in emergencies should be located in a well-shielded area supplied with uncontaminated air. (E.4b)

2. An adequate supply of the radiation protective (thyroid blocking) agent, potassium iodide for human use, should be available regionally for distribution to the general population and workers affected by a radiological emergency. (E.5)

3. Before a utility is granted an operating license for a new nuclear power plant, the state within which that plant is to be sited must have an emergency response plan reviewed and approved by the Federal Emergency Management Agency (FEMA). The agency should assess the criteria and procedures now used for evaluating state and local government plans and for determining their ability to activate the plans. FEMA must assure adequate provision, where necessary for multi-state planning. (F.1a)

4. The state must effectively coordinate its planning with the utility and with local officials in the area where the plant is to be located. (F.1c)

5. States with plants already operating must upgrade their plans to the requirements to be set by FEMA. Strict deadlines must be established to accomplish this goal. (F.1d)

6. No single plan based on a fixed set of distances and a fixed set of responses can be adequate. Planning should involve the identification of several different kinds of accidents with different possible radiation consequences. For each such scenario, there should be clearly identified criteria for the apppropriate responses at various distances, including instructing individuals to stay indoors for a period of time, providing special medication, or ordering an evacuation. (F.2a)

7. Similarly, response plans should be keyed to various possible scenarios and activated when the nature and potential hazard of a given accident has been identified. (F.2b)

8. If emergency planning and response to a radiation-related emergency is to be effective, the public must be better informed about nuclear power. The commission recommends a program to educate the public on how nuclear power plants operate, on radiation and its health effects, and on protective actions against radiation. Those who would be affected by such emergency planning must have clear information on actions they would be required to take in an emergency. (F.4)

9. Federal and state agencies, as well as the utility, should make adequate preparation for a systematic public information program so that in time of a radiation-related emergency, they can provide timely and accurate information to the news media and the public in a form that is understandable. There should be sufficient division of briefing responsibilities as well as availability of informed sources to reduce confused and inaccurate information. (G.1)

10. The provision of accurate and timely information places special responsibilities on the official sources of this information. The effort must meet the needs of the news media for information but without compromising the ability of operational personnel to manage the accident. (G.2)

11. The coverage of nuclear emergencies places special responsibilities on the news media to provide accurate and timely information. (G.3)

12. The Commission recommends that the public in the vicinity of a nuclear power plant be routinely informed of local radiation measurements that depart appreciably from normal background radiation, whether from normal or abnormal

operation of the nuclear power plant, from a radioactivity cleanup operation such as that at TMI-2, or from other sources. (G.5)

TMI-2 LESSONS LEARNED TASK FORCE STATUS REPORT AND SHORT-TERM RECOMMENDATIONS (NUREG-0578)

1. Review and upgrade the capability to obtain samples from the reactor coolant system and containment atmosphere under high readioactivity conditions. Provide the capability for chemical and spectrum analysis of high-level samples on site. (2.18a)

2. Provide high range radiation monitors for noble gases in plant effluent lines and a high-range radiation monitor in the containment. Provide instrumentation for monitoring effluent release lines capable of measuring and identifying radioiodine and particulate radioactive effluents under accident conditions. (2.18b)

3. Provide instrumentation for accurately determining in-plant airborne radioiodine concentrations to minimize the need for unnecessary use of respiratory protection equipment (2.1.8c)

4. Perform anlayses and implement procedures and training for prompt recognition of low reactor coolant level and inadequate core cooling using existing reactor instrumentation (flow, temperature, power, etc.) or short-term modifications of existing instruments. Describe further measures and provide supporting analyses that will yield more direct indication of low reactor coolant level and inadequate core cooling such as reactor vessel water level instrumentation. (2.1.3b)

5. Perform a design review of the shielding of systems processing primary coolant outside of containment. Determine any areas or equipment that are vital for post-accident occupancy or operation and assure that access and performance will not be unduly impaired due to radiation from these systems. (2.1.6b)

6. Review plant emergency procedures, and revise as necessary, to assure that access to the control room under normal and accident conditions is limited to those persons necessary to the safe command and control of operations. (2.2.2a)

7. A separate technical support center shall be provided for use by plant management, technical, and engineering support personnel. In an emergency, this center shall be used for assessment of plant status and potential offsite impact in support of the control room command and control function. The center should also be used in conjunction with implementation of onsite and offsite emergency plans, including communications with an offsite emergency response center. Provide at the onsite technical support center the as-built drawings of general plant arrangements and piping, instrumentation, and electrical systems. Photographs of as-built system layouts and locations may be an acceptable method of satsifying some of these needs. (2.2.2b)

8. Each operating nuclear power plant should establish and maintain a separate onsite operational support center outside the control room. In the event of an emergency, shift support personnel (e.g., auxiliary operators and technicians) other than those required and allowed in the control room shall report to this center for further orders and assignment. (2.2.2c)

THREE MILE ISLAND- A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. A provision for public information should be incorporated in the emergency response plans of both the NRC and the utility, and those plans should be coordinated with State, county or local plans. (p. 130)

2. The NRC should satisfy itself that every licensee for an operating reactor has evaluated the adequacy of emergency operating procedures. (p. 130)

3. The President's Commission recommended that Federal emergency planning functions for accidents at nuclear reactors should be consolidated into a single Federal agency. We agree. The new Federal Emergency Management Agency (FEMA), rather than the NRC or the Department of Energy, appears to us to be the appropriate agency for such planning. FEMA's principal mission is to help States plan for the logistics and communications involved in protective action, including evacuation, made necessary by any one of a variety of natural disasters or accidents. FEMA is in a better position to coordinate planning and action by State and local authorities, with whom it deals regularly, than the NRC. (p. 131)

4. We believe that consideration must be given by the NRC and FEMA to the method by which funds can be made available to local communities near nuclear plants. One suggestion has been that specific Federal grants be provided for such activity. Another is that the NRC should require utilities to pay for local planning efforts. (p. 132)

NRC'S BULLETINS AND ORDERS TASK FORCE RECOMMENDATIONS

1. Require central water level recording. (C.3.23)

REPORT OF THE SPECIAL REVIEW GROUP, OFFICE OF INSPECTION AND ENFORCEMENT, NRC (NUREG-0616)

1. All Part 50 and 70 licensees should review existing emergency plans and implementing procedures to ensure that specified actions can be performed. This review should include but not be limited to an assessment of the following:

--availability and operability of survey instruments

--availability and adequacy of vehicles to be utilized by environmental survey teams:

--4-wheel drive vehicles

--snowmobiles, etc.

--boats

--helicopters

--availability of direct reacting dosimeters

--availability, range, location, and readout of plant radiation instrumentation

--ability to sample in high radiation fields

--location and availability of counting laboratories during high implant radiation levels

--availability and adequacy of environmental samplers:

--resin columns for iodine in milk

--silver zeolite in charcoal adsorber cartridges

--battery or generator

--TLDs (3.9.1.1)

2. Require that licensees review emergency plans and available equipment for adequacy in the event of a major accident. Licensees should procure equipment, revise the emergency plan and procedures, initiate contractual support services, etc., as necessary. (3.13.5.2)

3. Review Part 50 and 70 licensee training records and interview trainees to ensure adequate training and resultant qualifications in the various areas of emergency preparedness. Verify that personnel assigned meet or exceed the training requirements of ANSI N18.1 and/or other applicable guidance. (3.7.1.1)

4. Review shift staffing procedures to ensure that all emergency team, emergency organization, and minimum shift crew training and qualifications are met when personnel are assigned or selected for a shift. (3.7.1.2)

5. If the above have not been specifically inspected since March 1979, they should be inspected by March 1980.

6. Licensee personnel should be given additional training in plant operations under emergency conditions or when high contamination is present. (3.7.1.3)

7. Amend 10 CFR 50.54, "Conditions of Licenses," to state:

"The licensee shall maintain for the life of the facility an adequate state of emergency preparedness, as specified in Appendix E. A license may be revoked, suspended, or modified for failure of the licensee to maintain an adequate emergency preparedness capability. The Commission shall conduct tests, as necessary, to demonstrate compliance with this part." (The last sentence is consistent with Parts 30.53 and 70.56.) (3.13.8.1)

8. Amend Regulatory Guide 1.101, Annex B, Section 2.3.5, "Tests and Drills," to include a third paragraph, as follows:

"Licensees shall establish a program for the conduct of tests of the emergency plan, implementing procedures, facilities, equipment, personnel, and other organizations. The test program function shall demonsrtate adequate capability to implement all portions of the emergency plan, implementing procedures, facilities, equipment, personnel, and other organizations at least annually." (3.13.8.2)

9. Develop and publish criteria for determining when the licensee's test, as described in 8 , above, is unacceptable In addition, IE and NRR should jointly participate in the development of criteria, scenarios, and administration of the NRC test as identified in recommendation (8), above, upon licensee failure to conduct an adequate test or demonstrate unsatisfactory performance. (3.13.8.3)

10. Each Part 50 and 70 licensee's emergency plans and procedures should include the name, location, and number of individuals, companies, governmental agencies, and other utilities which could furnish either personnel or equipment in support of the licensee's emergency effort. This should include but not be limited to:

--Technical personnel from vendors, architect/engineers, and other contractors associated with design and development of the plant.

--Operations and health physics personnel from other utilities.

--Local commercial suppliers of office equipment, trailers, and canteen services.

--Radiation protection and environmental monitoring consultants.

--Contract security agencies to supplement security force.

--Local military bases which can furnish logistical support. (3.9.2)

11. Require all Part 50 and Part 70 licensees to review their emergency notification procedures and ensure that key management personnel are equipped with beeper units to enhance prompt communication in an emergency. (3.11.1)

12. Require Part 50 and Part 70 licensees to review their emergency communication capabilities and to consider:

--purchase of additional portable MF transceivers and charging units.

--installation of FM mobile units in site emergency and survey vehicles.

--installation of repeaters in the vicinity of the site.

--installation of a hard wired antenna for the control building.

--installation of wiring for an NRC antenna to be connected in the event of an accident.

--installation of National Warning System (NAWAS) radio communications to the State NAWAS system and provision of the system with vital power. (3.11.3)

13. During future accidents, both the NRC and the licensee should appoint a communications or information coordinator to accumulate and transmit data from field teams. (3.11.5)

14. Require that licensees review current emergency plans to ensure that procedures identify a responsible member of the emergency organization who will coordinate initial requests for supply and equipment assistance from offsite support groups. (3.13.5.1)

15. Require that licensees review emergency plans and available equipment for adequacy in the event of a major accident. Licensees should procure equipment, revise the emergency plan and procedures, initiate contractual support services, etc., as necessary. (3.13.5.2)

16. Require all licensees to review facility training records for each individual functioning in a position described in the emergency plan. For each individual identified, the licensee training program should certify successful completion of formal training courses and examinations, and successful drill participation every two years.

17. Require all Part 50 and 70 licensees to review shift staffing, emergency training records, and the emergency plan team requirements to ensure that emergency responsibilities are clearly assigned to qualified individuals and that multiple assignments are avoided. (3.13.9)

18. Require all Part 50 and 70 licensees to adopt Regulatory Guide 1.101 to ensure standardized criteria and action levels. Each licensee should identify plant-specific criteria to allow determination of the applicable threshold. (3.13.10.1)

19. Require immediate notification via the NRC "hot line" telephone of all plant, site, or general emergencies. For these three classes, specific criteria for reactors should include at least:

--plant emergency

--site emergency

--general emergency (3.13.10.2)

20. Publish similar criteria for immediate notification by other licensees equipped with NRC hotlines. (3.13.10.3)

21. Revise IE Manual Chapter 1300 to reflect the five Regulatory Guide 1.101 severity level classifications. (3.13.10.4)

22. Revise and standardize regional emergency plans to be consistent with IE Manual Chapter 1300 and Regulatory Guide 1.101. (3.13.10.5)

23. Require licensees to incorporate into their emergency procedures and to keep current the following:

--lists and telephone numbers of senior operating personnel at similar plants.

--lists and telephone numbers of steam system supplier, architect/engineer, and other contractor personnel involved in design or construction of the facility. The licensee should be required to ensure that prompt technical support is available at all times. (3.11.4)

24. Establish a task group of IE and other NRC personnel, including the Telecommunications Branch, to evaluate and determine the feasibility of such telemetry systems and alternatives. (3.11.10.1)

25. Use the existing TERA system to store facility data for display in the NRC Operations Center complex. (3.11.10.2)

Task III.A.2: Improving Licensee Emergency Preparedness-Long Term

The objective is to upgrade the emergency preparedness of the nuclear power-plants.

ACTION ITEMS	PRIORITY		ESTIMATED COST			SCHEDULE	
	NRC's	Industry's	NRC		Industry	Begin	End
			1980	1981	1980 - 1981		
1. Amend 10 CFR 50 and 10 CFR 50, Appendix E	3	-	1.2my $90K	0.3my	Included in item III.A.1.2.	1979	1980
2. Development of Guidance and Criteria	3	-	Included in item III.A.1.1.		Included in item III.A.1.2.	Completed	

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. The NRC or its successor should, on a case-by-case basis, before issuing a new construction permit or operating license, condition the licensee upon review and approval of the state and local emergency plans. (A.8c)

2. Since, under our recommendations, accountability for operations during an emergency would rest on the licensee, the licensee must prepare clear procedures defining management roles and responsibilities in the event of a crisis. (B.3c)

3. An adequate supply of the radiation protective (thyroid blocking) agent, potassium iodide for human use, should be available regionally for distribution to the general population and workers affected by a radiological emergency. (E.5)

4. Before a utility is granted an operating license for a new nuclear power plant, the state within which that plant is to be sited must have an emergency response plan reviewed and approved by the Federal Emergency Management Agency (FEMA). The agency should assess the criteria and procedures now used for evaluating state and local government plans and for determining their ability to activate the plans. FEMA must assure adequate provision, where necessary, for multi-state planning. (E.1a)

5. The state must effectively coordinate its planning with the utility and with local officials in the area where the plant is to be located. (E.1c)

6. States with plants already operating must upgrade their plans to the requirements to be set by FEMA. Strict deadlines must be established to accomplish this goal. (E.1d)

7. No single plan based on a fixed set of distances and a fixed set of responses can be adequate. Planning should involve the identification of several different kinds of accidents with different possible radiation consequences. For each such scenario, there should be clearly identified criteria for the appropriate responses at various distances, including instructing individuals to stay indoors for a period of time, providing special medication, or ordering an evacuation. (F.2a)

8. Similarly, response plans should be keyed to various possible scenarios and activated when the nature and potential hazard of a given accident has been identified. (F.2b)

9. If emergency planning and response to a radiation-related emergency is to be effective, the public must be better informed about nuclear power. The Commission recommends a program to educate the public on how nuclear power plants operate, on radiation and its health effects, and on protective actions against radiation. Those who would be affected by such emergency planning must have clear information on actions they would be required to take in an emergency. (F.4)

10. Federal and state agencies, as well as the utility, should make adequate preparation for a systematic public information program so that in time of a radiation-related emergency, they can provide timely and accurate information to the news media and the public in a form that is understandable. There should be sufficient division of briefing responsibilities as well as availability of informed sources to reduce confused and inaccurate information. (G.1)

11. The provision of accurate and timely information places special responsibilities on the official sources of this information. The effort must meet the needs of the news media for information but without compromising the ability of operational personnel to manage the accident. (G.2)

12. The coverage of nuclear emergencies places special responsibilities on the news media to provide accurate and timely information. (G.3)

13. State emergency plans should include provision for creation of local broadcast media networks for emergencies that will supply timely and accurate information. Arrangements should be made to make available knowledgeable briefers to go on the air to clear up rumors and explain conditions at the plant. Communications between state officials, the utility, and the network should be prearranged to handle the possibility of an evaucation announcement. (G.4)

14. The Commission recommends that the public in the vicinity of a nuclear power plant be routinely informed of local radiation measurements that depart appreciably from normal or abnormal operation of the nuclear power plant, from a radioactivity cleanup operation such as that at TMI-2, or from other sources. (G.5)

TMI-2 LESSONS LEARNED TASK FORCE STATUS REPORT AND SHORT-TERM RECOMMENDATIONS (NUREG-0578)

1. Review plant emergency procedures, and revise as necessary, to assure that access to the control room under normal and accident conditions is limited to those persons necessary to the safe command and control of operations. (2.2.2a)

2. A separate technical support center shall be provided for use by plant management, technical, and engineering support personnel. In an emergency, this center shall be used for assessment of plant status and potential offsite impact in support of the control room command and control function. The center should also be used in conjunction with implementation of onsite and offsite emergency plans, including communications with an offsite emergency response center. Provide at the onsite technical support center the as-built drawings of general plant arrangements and piping, instrumentation, and electrical systems. Photographs of as-built layouts and locations may be an acceptable method of satisfying some of these needs. (2.2.2b)

3. Each operating nuclear power plant should establish and maintain a separate onsite operational support center outside the control room. In the event of an emergency, shift support personnel (e.g., auxiliary operators and technicians) other than those required and allowed in the control room shall report to this center for further orders and assignment. (2.2.2c)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. Once criteria for minimum workable evacuation areas are established by the NRC, prudence dictates that plants that cannot meet these criteria should be shut down, unless: (1) additional safety systems for the mitigation of accidents can be installed either to reduce the area of likely accident consequences or to increase the permissible time for evacuation; or (2) there is a determination by the President that the temporary continued operation of the plant is vital to the national interest. (p. 133)

2. Evacuation of citizens at least 10 miles around a nuclear power plant must be considered as an independent means of protection over and above the engineered safey features designed to mitigate an accident and prevent radiological releases. Distances should be regarded as the ultimate defense-in-depth barrier. (p. 130)

3. Plant operation should not be made absolutely contingent on approved local plans since this would, in effect, give local municipal governments the power to close a plant. (p. 131, 132)

4. The NRC should satisfy itself that every licensee for an operating reactor has evaluated the adequacy of emergency operating procedures. (p. 146)

REPORT OF THE SPECIAL REVIEW GROUP OFFICE OF INSPECTION AND ENFORCEMENT, NRC (NUREG-0616)

1. Monitor development of the AIF emergency organization scheme for all licensees and incorporate into Regulatory Guide 1.101, if appropriate. (3.4.4.4)

2. Establish and announce a firm policy regarding the responsibility and authority of licensees to follow and the authority of licensees to violate regulations and license conditions during emergencies. Provide additional guidance, as necessary, for the benefit of licensees and IE inspectors. (3.5)

3. Publish a statement of NRC policy regarding assisting licensees. The statement should identify conditions (e.g., licensee unavailable, undermanned, or overwhelmed) under which assistance might be warranted. The statement also

should discuss the limits of providing advice, direction, and equipment. (3.6.1)

4. Referencing the statutory authority, publish a statement of NRC policy regarding takeover from licensees. The statement should identify conditions under which takeover might be warranted, such as:

--licensee unavailable

--licensee proposing to perform or performing actions which are not prudent or legal

--licensee understaffed or overwhelmed

--licensee uncooperative. (3.6.2)

5. Amend 10 CRF 50.59, "Changes, Tests, and Experiments," 10 CFR 50.59(a)(2), which defines an "unreviewed safety question," to include the emergency plan, emergency plan implementing procedures, and emergency resources, equipment, and instrumentation. (3.13.1.2)

6. Amend 10 CFR 50.54, "Conditions of Licenses," to clarify that 10 CFR 50, Appendix E, is a license requirement. (3.13.1.1)

7. Revise Regulatory Guide 1.101 to specifically reference support which may be received from other utilities or contractors. (3.13.6.1)

8. Require all licensees to review their emergency organization to identify where special advisory groups and technical support will be incorporated. The review should include preplanning to identify similar facilities from which to obtain assistance. The licensees should ensure that their organization is consistent with their Technical Specifications and Emergency Plan. (3.13.6.2)

10. Amend Regulatory Guide 1.101 to provide an Annex C containing several detailed scenarios acceptable to be used for drills. (3.13.7.2)

11. Amend Regulatory Guide 1.101, Annex B, Section 2.3.5, "Tests and Drills," to include a third paragraph, as follows:

"Licensees shall establish a program for the conduct of tests of the emergency plan, implementing procedures, facilities, equipment, personnel, and other organizations. The test program function shall demonstrate adequate capability to implement all portions of the emergency plan, implementing procedures, facilities, equipment, personnel, and other organizations at least annually." (3.13.8.2)

12. Develop and publish criteria for determining when the licensee's test, as described in recommendation (2), above, is unacceptable. In addition, IE and NRR should jointly participate in the development of criteria, scenarios, and administration of the NRC test as identified in recommendation (1), above, upon licensee failure to conduct an adequate test or demonstrate unsatisfactory performance. (3.13.8.3)

13. Require NRC Part 50 licensees to immediately review their emergency plans and their applicable State Protective Action Guides to verify that action levels specified in the Protective Action Guides are incorporated into the emergency plan and implementing procedures. (3.13.2)

14. Issue a Temporary Instruction requiring a comprehensive inspection of licensees' personnel accountability and access control programs by March 1980. (3.13.3)

15. Require all licensees to review current reentry/recovery plans and procedures to ensure adequate planning, including, but not limited to: facility models, such as TMI; accident personnel control; adequately (conspicuously) labeled valves and pipes; photographs/drawings of plant area with valve and equipment locations; and high level sampling procedures. (3.13.4.1)

16. IE and NRR should evaluate the need for the development of post-accident plant operations procedures. Required licensee procedures should be promulgated via a change to Regulatory Guide 1.33.

Task III.A.3: Improving NRC Emergency Preparedness

The objective is to enable NRC, in the event of a nuclear accident at a licensed reactor facility, to (1) monitor and evaluate the situation and potential hazards, (2) advise the licensee's operating staff as needed, and (3) in an extreme case, be able to issue orders governing such operations.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC		Industry		Begin	End
			1980	1981	1980	1981		
1. NRC Role in Responding to Nuclear Emergencies	1	-	1.6my $200K	1.7my $225K	-	-	1980	1980
2. Improve Operations Centers	2	-	1.75my $700K		-	-		1981 (Regional)
3. Communications	2	3	1.3my $1.25M	1.1my $1.9M	-	-		1980
4. Nuclear Data Link	3	-	0.6my $550K	0.4my $126K	To be defined			1980 (phase 1)
5. Training, Drills, and Tests	To be scheduled and assigned resources along with normal agency functions.							
6. Interaction of NRC with Other Agencies	2	-	0.8my	-	-	-		1980 (international)

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. Emergency plans must detail clearly and consistently the actions public officials and utilities should take in the event of off-site radiation doses resulting from release of radioactivity. (F.1)

2. Plans for providing federal technical support, such as radiological monitoring, should clearly specify the responsibilities of the various support agencies and the procedures by which those agencies provide assistance. Existing plans for the provision of federal assistance, particularly the Interagency Radiological Assistance Plan and the various memoranda of understanding among the agencies, should be reexamined and revised by the appropriate federal authorities in the light of the experience of the TMI accident, to provide for better coordination and more efficient federal support capability. (F.6)

3. Federal and state agencies, as well as the utility, should make adequate preparation for a systematic public information program so that in time of a radiation-related emergency, they can provide timely and accurate information to the news media and the public in a form that is under-

standable. There should be sufficient division of briefing responsibilities as well as availability of informed sources to reduce confused and inaccurate information. (G.1)

TMI-2 LESSONS LEARNED TASK FORCE FINAL REPORT (NUREG-0585)

1. The Task Force recommends the establishment of a designated NRR Emergency Response Team (ERT) to be on immediate call in the event of emergencies. The ERT should be a multi-disciplinary group composed of NRR personnel knowledgeable in reactor systsm, instrumentation and control, core physics, accident analysis, radiation control, and health physics. In the selection of team members, emphasis should be given to applicable operations experience where possible, and the team should be trained and drilled regularly in emergency response. The Task Force recommends that the Emergency Response Team be identified and on call by November 15, 1979, and at least several members of that team be relieved temporarily of normal duties to devote full time to the initial ERT task (to be completed by February 1, 1980) of identifying resource requirements, procedures, training, and facilities, including deployment in the field, to enable effective emergency response by NRR in support of the Executive Management Team and the Incidence Response Action Coordination Team (IRACT) in the NRC Incident Response Center. The Task Force further recommends that the Commission consider the potential for NRC involvement in nuclear emergencies in foreign countries and provide definitive ground rules for the NRC staff role in such response. (13)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. We recommend that DOE be formally designated by executive order as the lead and coordinating Federal agency to call upon and organize the emergency resources of all other Federal agencies in case of an accident at a commercial nuclear plant requiring monitoring. EPA should be assigned long-term monitoring responsibilities after an accident, and HEW should be given the lead responsibility for population dose assessments and calculations of health impacts. (p. 137)

2. We also recommend that serious consideration be given to installation of real-time, online monitoring devices around

every nuclear plant in concentric circles at various distances from the plant site (for example, from the site boundary out to perhaps a few miles) that can be read from the plant control room or some other remote site. Such a system would be expensive but not prohibitively so, and the technology poses no problem. We understand that such devices are currently being installed by requirement of the State of Illinois in the Chicago area to cover potential releases during any accident that might occur at any of the plants located in the vicinity. (p. 137)

3. NRR's "Lessons Learned" Report proposes that each utility be required to maintain an offsite emergency data center of its own where important plant parameters could be read. Additional stations such as these for remote readout would be useful, but we believe it is important to centralize the data center we have in mind so that experts in reactor systems, thermal-hydraulics, and radiation protection can be kept on duty 24 hours a day to respond instantly to emergencies. We do not view the centralized national (or regional) data center we propose as a substitute for training better control room operators and improving the onsite technical expertise of utility supervisors. The offsite data center would serve as a backup resource, capable of giving advice and counsel on perplexing instrument readings or sophisticated projections of how the plant is likely to react under certain severe conditions. The remote data center is no alternative to technically qualified, competent people on site, nor can it "take over" operation of the reactor. It should play a support role for engineering management in the control room. (p. 108)

4. We recommend that while the Executive Management Team (EMT) should be retained, it should have a single director. The director of the EMT should exercise the authority of the entire agency during an emergency. (p. 134)

5. In our view, the role of the EMT should be to mobilize the resources of the agency, to get a technically qualified group headed by a senior NRC official to the reactor site as soon as possible, to coordinate the agency's response until that team arrives, and thereafter to turn over the lead role to the site team and to serve as a backup and communications link to the team. (p. 134)

6. The NRC must not be constrained by its own attitudes to take such a passive role during an accident if circum-

stances demand more direct intervention. It appears that the NRC has the authority, under the existing licensing scheme, to require a utility licensee to undertake a particular action on the spot, if necessary to protect public health and safety. If there is any doubt on this score, legislation should be enacted to clarify the agency's responsibility. (p. 135)

7. We recommend that a senior NRC official knowledgeable about reactor operations and reactor engineering, and a technical team capable of backing him up, be sent to the site as soon as possible. (p. 135)

8. We suggest that emergency response procedures might be rewritten to provide that the director of the EMT or the onsite senior NRC official directing the NRC's emergency response may direct that (1) particular information be provided immediately to the NRC, or (2) a particular action be taken in the plant, where necessary in his judgement to protect public health and safety. (p. 136)

NRC'S BULLETINS AND ORDERS TASK FORCE RECOMMENDATIONS

1. One hour notification requirement, and continuous communications channel. (C.1.12)

2. Central water level recording. (C.3.23)

REPORT OF THE REVIEW GROUP, OFFICE OF INSPECTION AND ENFORCEMENT, NRC (NUREG-0616)

1. NRC and regional emergency response plans should include the name, location, and number of individuals, companies, and agencies that could furnish support. This should be site specific, where necessary, and should include but not be limited to:

--medical consultants

--other technical personnel and equipment

--additional monitoring capability (IE, DOE, EPA, State Environmental)

--local commercial suppliers of office equipment, trailers, vehicles, canteen services, and air travel

--contract security organization

--communication cababilities (Forestry, GSA, State Police)

--local military bases which can furnish logistical support (3.9.4.1)

2. Redesign and reconstruct the NRC Operations Center to support a major accident (Figure 3.9.5.2). As a minimum, the Operations Center should contain or be designed to the following criteria:

--EMT Room

--IRACT ROOM

--EVALUATION TEAM (ET) Rooms

--Communications Room

--Status Room

--Security Station

--Public Affairs Room

--File Room

--Rest Area (3.9.5.1)

3. Recognizing that recommendation 1, above, is essentially a "long term fix," the following items are recommended for a "short term fix" for the existing NRC Operations Center:

--Place acoustic material on the walls (and ceiling if necessary) in the EMT and IRACT rooms to reduce background noise.

--Install emergency lighting in the EMT and IRACT rooms.

--Install a voice recorder system in the EMT room.

--Install a Communications Room next to the EMT room. The Communications Room should have a master telephone console with all EMT and IRACT room extensions, and an office intercom system with existing intercom extensions. The Communications Room should be the location of the hotline telephone system from the licensees, and the location of the telephone recorder system. The Communications Room should have the "beeper" system and a status board to indicate holders. (3.9.5.2)

4. Provide each NRC regional office a dedicated Regional Response Center room with, as a minimum, the following:

--ten dedicated phone lines plus existing hotlines

--telephone recorder system for the dedicated phone lines

--status boards, maps, etc.

--telephone chaining capability for conference calls, on dedicated phone lines

--office page system

--reference room with reference materials, file cabinets, etc.

--TV and videotaping capability

--A DARE employee to maintain Response Center resources. (3.9.5.3)

5. Provide emergency lighting and around-the-clock air conditioning for all regional and headquarters emergency response facilities. (3.9.5.4)

6. Expedite installation of the second dedicated telephone line to each major facility. Both dedicated telephone lines should contain sufficient flexibility to accommodate additional tie-ins, such as from an offsite "command center" or trailer complex. (3.11.2.1)

7. Consider backup communication links to enhance reliability in the case of a Centrex interruption. For example,

a radiotelephone link to the licensee's microwave communication system may be appropriate. (3.11.2.2)

8. Establish contractual arrangements with telephone companies serving major facilities to ensure swift installation of telephone facilities necessary to support extensive communications following an accident. (3.11.2.3)

9. Establish a task group of IE and other NRC personnel, including the Telecommunications Branch, to evaluate and determine the feasibility of such telemetry systems and alternatives. (3.11.10.1)

10. Use of existing TERA system to store facility data for display in the NRC Operations Center complex. (3.11.10.2)

11. Require licensees to maintain normal logs, if possible, throughout an accident. (3.12.1.1)

12. As recommended in section 3.10.5, power reactor licensees should install in every reactor control room a reactor or turbine trip actuated, videotape camera/recorder and a multichannel voice recorder to capture conversations and instructions that otherwise might be lost. (3.12.1.2)

13. Licensees should consider the use of computerized storage systems to record, display, and analyze selected plant parameters. These systems should be powered by a vital power supply. (3.12.1.3)

14. Licensees should consider the installation of backup computer printout facilities to ensure that no records are lost in the event the printer fails or the paper runs out during an accident. (3.12.1.4)

15. Revise IE Manual Chapter 1300 to be consistent with the IE organization and NRC Manual Chapter 0502. Provide additional details concerning individual responsibilities. (3.4.2.1)

16. Clarify the emergency response role of the IE Regional Director. Specify a requirement for the Regional Director to go to the scene of any Site or General Emergancy, as defined in Regulatory Guide 1.101. (3.4.2.2)

17. Clarify "chain of command" relationships between the on-scene leader, the Regional Response Center, and the IRACT.

(This may be needed if the IRACT Director, due to the type of accident, is from outside IE.) (3.4.2.3)

18. Clarify Regional Response Center functions, once the NRC Operations Center is fully manned and the IRACT is functioning. It would appear that at this point the Regional Response Center team should become engaged in peer review and in rendering communication assistance to outside agencies or the media. The command, control, and communications link should be directly between the IRACT and the Regional Director, whether in the regional office or at the scene. Revise IE Manual Chapter 1310, "Regional Office Incident Response Actions," appropriately. (3.4.2.4)

19. Formally establish IE as the NRC component primarily responsible for NRC activities at accident sites. To the extent possible, predetermine a chain of command within and beyond IE to ensure proper direction of site activities and proper communication of site information. (3.3.3)

20. Conduct the following drills:

- --Regional
  - --one LOCA (power reactor) per year
  - --one LOCA (power reactor) concurrent with licensee drill once per year
  - --one fuel facility accident per year
  - --one test/research reactor accident per year
  - --one transportation accident per year
  - --one materials accident per year
- --The NRC Operations Center should participate with each region in one drill annually. At least one of these drills should be a LOCA concurrent with a licensee drill.
- --At least one of the regional and Operations Center drills should be conducted during non-business hours.

(3.14.5.1)

21. Assign each Regional Emergency Officer to observe and critique one drill in another region annually. (3.14.5.2)

22. Publish a concise statement of the IE emergency response mission, to include: ensuring the emergency preparedness of NRC and NRC licensees; providing direction and manpower following an accident involving NRC-licensed material; and ensuring the historical preservation of accident information for use in future prevention and response activities. (3.2.2)

23. Revise Manual Chapter 0502, "NRC Incident Response Program," to explicitly define IE's mission, particularly in the areas of onsite direction of NRC activities and providing assistance to the licensee. (3.2.3)

24. Once IE's emergency response mission is well stated (Section 3.2), its responsibility and resultant authority should be clearly assigned and distinguished from the responsibility and authority of other NRC Offices and other agencies. (3.3.1)

25. To the extend possible, regional emergency response organizations, plans, and procedures should be identical. An Emergency Officer position should be uniformly established in each region, as well as in headquarters, to ensure this. (3.3.4)

26. Form an ad hoc NRC Emergency Preparedness Committee representing Inspection and Enforcement, Nuclear Reactor Regulation, Nuclear Material Safety and Safeguards, Standards Development, Administration, Congressional Affairs, Public Affairs, and State Programs to revise the current IRP to include emergency plans and procedures for each participating NRC office.

27. Recommendations made by the Task Force on Emergency Planning should be acted upon by congizant managers. Interagency issues should be quickly resolved. (3.4.4.1)

28. Revise NRC Manual Chapter 0502 to provide guidance regarding coordination of the NRC emergency response actions with all outside agencies. (Current guidance pertains essentially to DOE and the FBI.) (3.4.3.2)

29. Take steps to ensure NRC acceptance as the lead agency for responding to nuclear emergencies. Clarify jurisdictional boundaries between NRC and other State/Federal agencies. (3.4.4.3)

30. Monitor development of the AIF emergency organization scheme for all licensees and incorporate into Regulatory Guide 1.101, if appropriate. (3.4.4.4)

31. IE should establish and maintain (via change notice system) a catalog describing organizational functions, responsibilities, and authorities of NRC and other Federal agency components, of State and smaller governmental agencies, and of medical, fire, police, and other emergency services in major cities and near licensed facilities. (3.3.2)

32. Formally establish IE as the NRC component primarily responsible for NRC activities at accident sites. To the extent possible, predetermine a chain of command within and beyond IE to ensure proper direction of site activities and proper communication of site information. (3.3.3)

33. Revise IE Manual Chapter 1300 to identify typical response teams for various classes of emergencies and to indicate typical initial tasks, as in the examples below. Include guidance and decision criteria to allow the Regional Director to determine the appropriate team size and composition. (3.3.5.1)

34. Advise licensees of the role of IE response teams. Arrange that such teams are granted immediate access to the site and/or control centers. (3.3.5.2)

35. Revise IE Manual Chapter 1300 to provide for the use of regional inspectors from unaffected regions as part of the NRC Operations Center support staff and as backup support at the scene. These individuals should be used to augment existing staff in areas such as communications, data/status maintenance, and evaluation. On-scene needs from unaffected regions will depend on the scope and duration of the emergency. (3.3.5.3)

36. Review current systems and procure at least ten portable radio transceivers, with repeater units, for each Regional office. This equipment should be standardized and interchangeable among regions. (3.11.6.1)

37. Equip each regional mobile laboratory (Section 3.14.3) with: 40-channel CB with high gain antenna; NAWAS and law enforcement transceiver, for the NRC portable radio system.

38. In lieu of actually purchasing a similar communication network and training personnel in its operation, NRC should accedlerate present negotiations with outside agencies and establish formal agreements to ensure communications when needed. (3.11.8)

39. IE should assist Tel Com in assessing and evaluating communications available to NRC at potential emergency locations. Develop a Temporary Instruction to examine these areas during routine inspections. Technical instruction to the inspectors could be furnished by Tel Com personnel visiting the regions. (3.11.9.1)

40. IE should arrange with Tel Com to furnish disaster and weather information to the Incident Response Action Coordination Team (IRACT) after an accident. (3.11.9.2)

41. Tel Com should arrange Early Reporting Service teletype communication between Region V and the National Earthquake Information Service, Golden, Colorado. (3.11.9.3)

42. Revise and standardize regional emergency plans to be consistent with IE Manual Chapter 1300 and Regulatory Guide 1.101. (3.13.10.5)

43. Form an ad hoc committee of regional representatives to revise existing regional emergency plans into a standard plan by March 1980. (3.14.2.1)

44. Designate in each region a senior emergency planning inspector as Regional Emergency Officer. He should have a collateral duty for maintaining the regional emergency plan, for coordinating emergency response planning between regions, and for conducting regional drills, as specified under Section 3.14.5). (3.14.2.2)

45. Staff the regional offices sufficiently to ensure that all personnel are not in travel between home and office at one time. (3.14.2.3)

46. Establish the following minimum capability in each region by mid-1980:

--mobile laboratory

--fixed support laboratory

--emergency monitoring kits

--response center (3.14.3.1)

47. Standardize equipment and instruments among regions to allow interchangeability and to ensure that support personnel responding from other regions are already trained and familiar with the equipment and instruments. (3.14.3.2)

48. Provide inspectors respirator mask spectable frames and glasses. (3.14.3.3)

49. Revise IE Manual Chapter 1300 and NRC Manual Chapter 0502 in conjunction with the committee assignments discussed in Sections 3.14.1 and 3.14.2. (Also, see Sections 3.2, 3.3, and 3.4.) (3.14.4)

50. Develop a personnel resources matrix as an addition to the IE staff data maintained by XOMA. Ultimately, such a matrix may be appropriate on an agency-wide basis. Examples of data to be stored include:

--individuals with containment leakage expertise

--individuals with vendor-specific core physics expertise

--individuals with large centifugal pump expertise

--metallurgists

--individuals with vendor-specific instrumentation expertise

--B&W site resident inspectors. (3.14.7)

51. As the organization chartered to take the lead in NRC emergency preparedness, IE should provide guidance and training to all NRC offices regarding emergency response functions and responsibilities. This would include formalized training/briefings to the Commissioners and to EMT and IRACT members. (3.4.3.1)

52. Identify key staff positions required to support IRACT for various types of emergencies. (3.4.3.2)

53. Establish criteria and procedures for NRR and other NRC offices to provide assistance to IE at the emergency site. (3.4.3.3)

54. Conduct drills annually, in conjunction with a licensee and regional drill, that would mobilize the entire headquarters incident response team. (3.4.3.4)

55. In each Regional Response Center and at the NRC Operations Center, maintain site reference books for each power reactor, test/research reactor, and fuel facility. (3.14.6)

56. Assign one or two investigators to the initial response team to observe and to protect the integrity of documentary evidence. (3.10.5.1)

57. Require that power reactor licensees install a video and sound recording system in every power reactor control room, to be activated in the event of a reactor or turbine trip. This sytem would record control room activities during the initial phases of an accident to assist NRC and licensee in reconstructing the facts of the accident. (3.10.5.2)

58. In the catalog of organizational functions, responsibilities, and authorities recommended in Section 3.3.2, define the interfaces of NRC and other Federal agency components; State and smaller governmental agencies; and medical, fire, police, and other emergency services in major cities and near major licensee facilities. For convenience, cross reference this catalog by organizational name and areas of responsibility. (3.4.1)

Task III.B: Emergency Preparedness of State and Local Government

The objective is to upgrade the state of emergency preparedness of state and local governments affected by nuclear facilities. The Federal Emergency Management Agency was given the lead on this effort by the President on December 7, 1979.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC		Industry		Begin	End
			1980	1981	1980	1981		
1. Transfer of Responsibilities to FEMA	1	-	2.5my $350K	0.5my	-	-	1979	1980
2. Implementation of NRC's and FEMA's Responsibilities	1	-	10-14my	10-14my	-	-	To be determined	

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. Emergency plans must detail clearly and consistently the actions public officials and utilities should take in the event of off-site radiation doses resulting from release of radioactivity. (F.1)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. Workable State emergency plans, approved by FEMA, should be a prerequisite to continued operation of existing and future reactors. (p. 132)

2. Plant operation should not be made absolutely contingent on approved local plans since this would, in effect, give local municipal governments the power to close a plant. (p. 131)

3. The President's Commission recommended that Federal emergency planning functions for accidents at nuclear reactors should be consolidated into a single Federal agency. We agree. The new Federal Emergency Management Agency (FEMA), rather than the NRC or the Department of Energy, appears to us to be the appropriate agency for such planning. FEMA's principal mission is to help States plan for the logistics and communications involved in protective action, including evacuation, made necessary by any one of a variety of natural disasters or accidents. FEMA is in a better

position to coordinate planning and action by State and local authorities, with whom it deals regularly, than the NRC. However, FEMA and the NRC must coordinate closely in this venture, and FEMA should make maximum use of the work that the NRC has already done and is presently doing. Because FEMA is still in the process of being organized, and lacks the expertise in particular aspects of protective action that may be appropriate in a radiological emergency NRC has an important role to play in defining the criteria for effective planning around each site. (p. 131)

4. We believe that consideration must be given by the NRC and FEMA to the method by which funds can be made available to local communities near nuclear plants. One suggestion has been that specific Federal grants be provided for such activity. Another is that the NRC should require utilities to pay for local planning efforts. (p. 132)

Task III.C: Public Information

The objective is to have information available for the news media and the public describing how nuclear plants operate, the existing radiation and its health effects, and protective actions against radiation provide training for members of the technical staff on how to interface with the news media and other interested parties.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC		Industry		Begin	End
			1980	1981	1980	1981		
1. Have Information Available for the News Media and the Public	3	-	0.6my	0.5my	-	-		1980
2. The Office of Public Affairs will Develop Agency Policy and Provide Training for Interfacing with the News Media and Other Interested Parties	3	-	0.1my	-	-	-	To be addressed in Commission paper May 1, 1980	

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. If emergency planning and response to a radiation-related emergency is to be effective, the public must be better informed about nuclear power. The Commission recommends a program to educate the public on how nuclear power plants operate, on radiation and its health effects, and on protective actions against radiation. Those who would be affected by such emergency planning must have clear information on actions they would be required to take in an emergency. (F.4)

2. Federal and state agencies, as well as the utility, should make adequate preparation for a systematic public information program so that in time of a radiation-related emergency, they can provide timely and accurate information to the news media and the public in a form that is understandable. There should be sufficient division of briefing responsibilities as well as availability of informed sources to reduce confused and inaccurate information. (G.1)

3. The provision of accurate and timely information places special responsibilities on the official sources of this information. The effort must meet the needs of the news media for information but without compromising the ability of operational personnel to manage the accident. (G.2)

4. The coverage of nuclear emergencies places special responsibilities on the news media to provide accurate and timely information. (G.3)

THREE MILE ISLAND - A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. Regulators must change their attitudes to appreciate that this perception of risk cannot be dealt with by trying to convince the public that it "can't happen." (p. 91)

2. Public misconception about the risks associated with the actual releases measured during the accident, as well as about the risks associated with nuclear powerplants generally, has been due to a failure to convey credible information regarding the actual risks in an understandable fashion to the public. We believe substantial efforts are necessary to provide such information and that the NRC should play an effective role in this task. (p. 154)

3. A provision for public information should be incorporated in the emergency response plans of both the NRC and the utility, and those plans should be coordinated with State, county or local plans. (p. 157)

Task III.D.1: Radiation Source Control

The objective is to perform evaluations to establish additional design features that should be included in the rulemaking proceeding of Item II.B.8. The purpose of this evaluation will be to identify design features that will reduce the potential for exposure to workers at nuclear powerplants and to offsite populations following an accident.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC		Industry		Begin	End
			1980	1981	1980	1981		
1. Primary Coolant Sources Outside the Containment Structure	2	-	1.3my $332K	0.8my $187K	$5K/plant (NTOL only)		1979	1981 (criteria development)
2. Radioactive Gas Management	3	-	-	-	-	-	1982 or later	
3. Ventilation System and Radioiodine Adsorber Criteria	2	3	-	-	-	-	1982 or later	
4. Radwaste System Design Features to Aid in Accident Recovery and Decontamination	3	-	-	-	-	-	1982 or later	

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. Consideration should be given to overall gas-tight enclosure of the let-down/make-up system with the option of returning gases to the containment building. (D.4.c(ii))

2. Equipment design and maintenance inadequacies noted at TMI should be reviewed from the point of view of mitigating the consequences of accidents. Inadequacies noted in the following should be corrected: iodine filters, the hydrogen recombiner, the vent gas system, containment isolation, reading of water levels in the containment isolation, reading of water levels in the containment area, radiation monitoring in the containment building, and the capability to take and quickly analyze samples of containment atmosphere and water in various places. (D.2)

3. The agency should be directed to include, as part of its licensing requirements, plans for the mitigation of the consequences of accidents, including the cleanup and recovery of the contaminated plant. The agency should be directed to review existing licenses and to set deadlines for accomplishing any necessary modifications. (A.7)

4. The Commission recommends that continuing in-depth studies should be initiated on the probabilities and consequences (on-site and off-site) of nuclear power plant accidents, including the consequences of meltdown. (D.4)

TMI-2 LESSONS LEARNED TASK FORCE STATUS REPORT AND SHORT-TERM RECOMMENDATIONS (NUREG-0585)

1. The Task Force recommends that the Commission is within three months a notice of intent to conduct rul- making to solicit comments on the issues and facts re to the consideration of design features to mitigate accidents that would result in (a) core-melt and (b) core damage, but not substantial melting. Specific a for comment should include, but not be limited to, the following:

(1) Are design features to mitigate the consequences either or both of these types of accidents neces to provide reasonable assurance that the health a safety of the public are protected?

(2) In lieu of such features, should additional and mental means of preventing core damage or core-me accidents, through improved engineered safety fea be required?

(3) What should be the objective of such design featu Should the design objectives be a set of specifi acceptance criteria (e.g., some limitation on cal lated offsite dose) or the reduction of potential site exposure that is reasonably achievable?

(4) What should be the characteristics and functions such design features?

(5) What are the probabilities and consequences of th various event sequences that might result in rele significant amounts of radioactivity to the envir ment? Which sequences are amenable to interdicti and by what means?

(6) What is the expected effectiveness and performanc suggested means of reducing the consequences of ev in which severe damage or substantial melting of core occurs, in particular, systems for controlle bustion of hydrogen?

(7) How should other requirements, and in particular for siting, emergency plans and procedures, train

other related areas, be modified if such design features were required?

(8) What additional information is required or desirable before setting requirements? What information is available, and what information needs to be developed through experiment, test, analysis, or evaluation?

(9) What should be the final form of the requirement, if any? What should be the implementation schedule for new plants, plants under construction, and operating plants?

The Task Force recommends that a proposed rule be published for public comment within one year of the notice of intent. (10)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. Should loss of core cooling and resultant core damage occur in a nuclear plant, there are certain predictable consequences that might be substantially mitigated, and the risk of severe public health danger thereby substantially reduced, by design improvements of less than staggering cost or complexity. Such improvements should be specifically evaluated in the normal design review basis. In particular, it appears that expedited consideration should be given to the use of vented, filtered containment systems to guard against the high-pressure rupture of existing containments, and to the redesign of some of the waste gas and filtering systems that will inevitably be exposed to water and gas coming from the primary system during an accident containing high concentrations of radioactive materials. On a selective basis, determine whether some design features to mitigate the effects of some Class Nine accidents should be required. (p. 151)

Task III.D.2: Public Radiation Protection Improvement

The objective is to improve public radiation protection in the event of a nuclear powerplant accident by improving: (1) radioactive effluent monitoring; (2) the dose analysis for accidental releases of radioiodine, tritium, and carbon-14; (3) the control of radioactivity released into the liquid pathway; (4) the measurement of offsite radiation doses; and (5) the ability to rapidly determine offsite doses from radioactivity released by meteorological and hydrological measurements so that population-protection decisions can be made appropriately.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC		Industry		Begin	End
			1980	1981	1980	1981		
1. Radiological Monitoring of Effluents	2	3	-	-	-	-	1982 or later	
2. Radioiodine, Carbon-14, and Tritium Pathway Dose Analysis	3	-	-	-	-	-	1982 or later	
3. Liquid Pathway Radiological Control	3	-	-	-	-	-	1982 or later	
4. Offsite Dose Measurements	3	3	5.3my $600K	3.7my $107K	To be determined		1980	1981
5. Offsite Dose Calculation Manual	3	3	-	-	-	-	1982 or later	
6. Independent Radiological Measurements	To be scheduled and assigned resources along with normal agency functions.							

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. The agency should be directed to include, as part of its licensing requirements, plans for the mitigation of the consequences of accidents, including the cleanup and recovery of the contaminated plant. The agency should be directed to review existing licenses and to set deadlines for accomplishing any necessary modifications. (A.7)

2. Equipment design and maintenance inadequacies noted at TMI should be reviewed from the point of view of mitigating the consequences of accidents. Inadequacies noted in the following should be corrected: iodine filters, the hydrogen recombiner, the vent gas system, containament isolation, reading of water levels in the containment isolation, reading of water levels in the containment area, radiation monitoring in the containment building, and the capability to take and quickly analyze samples of containment atmosphere and water in various places. (D.2)

3. Monitoring instruments and recording equipment should be provided to record continuously all critical plant measurements and conditions. (D.3)

4. A study should be made of the chemical behavior and the extensive retention of radioactive iodine in water, which resulted in the very low release of radioiodine to the atmosphere in the TMI-2 accident. This information should be taken into account in the studies of the consequences of other small-break accidents. (D.5)

5. Radiation monitors should be available for monitoring of routine operations as well as accident levels. (E.4a)

6. Results of these studies should be used to help plan for recovery and cleanup following a major accident. (D.4b)

7. From these studies may emerge desirable modifications in the design of plants that will help prevent accidents and mitigate their consequences. For example:

    (a) Consideration should be given to equipment that would facilitate the controlled safe venting of hydrogen gas from the reactor cooling system.

    (b) Consideration should be given to overall gas-tight enclosure of the let-down/make-up system with the option of returning gases to the containment building. (D.4c)

8. There must be a sufficient health-related supply of instruments, respirators, and other necessary equipment for both routine and emergency conditions. (E.4c)

9. There should be an adequate maintenance program for all such health-related equipment. (E.4d)

10. Plans for providing federal technical support, such as radiological monitoring, should clearly specify the responsibilities of the various support agencies and the procedures by which those agencies provide assistance. Existing plans for the provision of federal assistance, particularly the Interagency Radiological Assistance Plan and the various memoranda of understanding among the agencies, should be reexamined and revised by the appropriate federal authorities in the light of the experience of the TMI accident, to provide for better coordination and more efficient federal support capability. (F.6)

11. An adequate supply of the radiation protective (thyroid blocking) agent, potassium iodide for human use, should be

available regionally for distribution to the general population and workers affected by a radiological emergency. (E.5)

12. The agency should be directed to require its enforcement personnel to perform improved inspection and auditing of licensee compliance with regulations and to conduct major and unannounced on-site inspections of particular plants. (A.11d)

TMI-2 LESSONS LEARNED TASK FORCE STATUS REPORT AND SHORT-TERM RECOMMENDATIONS (NUREG-0578)

1. Provide high range radiation monitors for noble gases in plant effluent lines and a high-range radiation monitor in the containment. Provide instrumentation for monitoring effluence release lines capable of measuring and identifying radioiodine and particulate radioactive effluents under accident conditions. (2.1.8b)

2. Review plant emergency procedures, and revise as necessary, to assure that access to the control room under normal and accident conditions is limited to those persons necessary to the safe command and control of operations. (2.2.2a)

3. A separate technical support center shall be provided for use by plant management, technical, and engineering support personnel. In an emergency, this center shall be used for assessment of plant status and potential offsite impact in support of the control room command and control function. The center should also be used in conjunction with implementation of onsite and offsite emergency plans, including communications with an offsite emergency response center. Provide at the onstie technical support center the as-built drawings of general plant arrangements and piping, instrumentation, and electrical systems. Photographs of as-built system layouts and locations may be an acceptable method of satisfying some of these needs. (2.2.2b)

4. Each operating nuclear power plant should establish and maintain a separate onsite operational support center outside the control room. In the event of an emergency, shift support personnel (e.g., auxiliary operators and technicians other than those required and allowed in the control room shall report to this center for further orders and assignment. (2.2.2c)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. We also recommend that serious consideration be given to installation of real-time, online monitoring devices around every nuclear plant in concentric circles at various distances from the plant site (for example, from the site boundary out to perhaps a few miles) that can be read from the plant control room or some other remote site. Such a system would be expensive but not prohibitively so, and the technology poses no problem. We understand that such devices are currently being installed by requirement of the State of Illinois in the Chicago area to cover potential releases during any accident that might occur at any of the plants located in the vicinity. (p. 137)

REPORT OF THE SPECIAL REVIEW GROUP, OFFICE OF INSPECTION AND ENFORCEMENT, NRC (NUREG-0616)

1. The Office of Inspection and Enforcement should take additional action to emphasize observation of work activities. (2.2.1.1)

2. An expansion of independent assessment with adequate planning, direction, management and guidance should be undertaken. The correct ratio of IE to contractor resources should be established and procedures developed. A dedicated task group with actual power plant experience in diverse areas such as calibration, NDE, and HP should be created to oversee development of this program. (2.2.2)

3. Determine regional instrument and equipment needs and transportation methods. Purchase instrument, equipment, calibration sources, carrying cases, and other accessories, and provide specialized training regarding calibration and use. Establish a full-time position at each region for the purpose of maintaining, calibrating, and transporting such instruments and equipment. (3.9.3.1)

4. Procure a mobile whole body counter to be installed at one regional office, which would transport it to any accident site, as necessary. (3.9.3.2)

5. Publish a statement of policy regarding postaccid independent measurements. On the basis of this policy, establish a continuing program for uniformly training a equipping regional personnel to perform such measuremen Establish a centrally located facility to provide these ing and equipment services and to provide radiochemistr support to the regions during both normal and emergency operations. (3.6.3)

6. Establish the following minimum capability in each by mid-1980:

--mobile laboratory

--fixed support laboratory

--emergency monitoring kits

--response center (3.14.3.1)

7. Standardize equipment and instruments among region allow interchangeability and to ensure that support per responding from other regions are already trained and fa iar with the equipment and instruments. (3.14.3.2)

8. Provide inspectors respirator mask spectacle frames glasses. (3.14.3.3)

Task III.D.3: Worker Radiation Protection Improvements

The objective is to improve nuclear powerplant worker radiation protection to allow workers to take effective action to control the course and consequences of an accident, as well as to keep exposures as low as reasonably achieveable (ALARA) during normal operation and accidents, by improving radiation protection plans, health physics, inplant radiation monitoring, control room habitability, and radiation worker exposure data base.

ACTION ITEMS	PRIORITY NRC's	PRIORITY Industry's	ESTIMATED COST NRC 1980	ESTIMATED COST NRC 1981	ESTIMATED COST Industry 1980	ESTIMATED COST Industry 1981	SCHEDULE Begin	SCHEDULE End
1. Radiation Protection Plans	2	3	-	-	-	-	1982 or later	
2. Health Physics Improvements	To be scheduled and assigned resources along with normal agency functions.							
3. Inplant Radiation Monitoring	3	2	0.5my $65K	0.4my $125K	0.4my $50K	per reactor	1979	1982
4. Control Room Habitability	2	2	0.9my $110K	2.1my $90K	2.0my $500K	per reactor	1980	1983
5. Radiation Worker Exposure Data Base	2		To be scheduled and assigned resources along with normal agency functions.					

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. The agency should be directed to employ a broader definition of matters relating to safety that considers thoroughly the full range of safety matters, including, but not limited to, those now identified as "safety-related" items, which currently receive special attention. (A.4b)

2. Responsibility and accountability for safe power plant operations, including the management of a plant during an accident, should be placed on the licensee in all circumstances. It is therefore necessary to assure that licensees are competent to discharge this responsibility. To assure this competency, and in light of our findings regarding Metropolitan Edison, we recommend that the agency establish and enforce higher organizational and management standards for licensees. Particular attention should be given to such matters as the following: integration of decision-making in any organization licensed to construct or operate a plant; kinds of expertise that must be within the organization; financial capability; quality assurance programs; operator and supervisor practices and their periodic reevaluation; plant surveillance and maintenance practices; and requirements for the analysis and reporting of unusual events. (A.5)

3. The agency should be directed to include, as part of its licensing requirements, plans for the mitigation of the consequences of accidents, including the cleanup and recovery of the contaminated plant. The agency should be directed to review existing licenses and to set deadlines for accomplishing any necessary modifications. (A.7)

4. Although the Commission considers the responsibility for safety to be with the total organization of the plant, we recommend that each nuclear power plant company have a separate safety group that reports to high-level management. Its assignment would be to evaluate regularly procedures and general plant operations from a safety perspective; to assess quality assurance programs; and to develop continuing safety programs. (B.2)

5. Integration of management responsibility at all levels must be achieved consistently throughout this industry. Although there may not be a single optimal management structure for nuclear power plant operation, there must be a single accountable organization with the requisite expertise to take responsibility for the integrated management of the design, construction, operation, and emergency response functions, and the organizational entities that carry them out. Without such demonstrated competence, a power plant operating company should not qualify to receive an operating license. (B.3)

6. It is important to attract highly qualified candidates for the positions of senior operator and operator supervisor. Pay scales should be high enough to attract such candidates. (B.4)

7. Utilities must make sufficient advance preparation for the mitigation of emergencies. (E.4)

8. There must be a sufficient health-related supply of instruments, respirators, and other necessary equipment for both routine and emergency conditions. (E.4c)

9. Radiation monitors should be available for monitoring of routine operations as well as accident levels. (E.4a)

10. Development of methods of monitoring and surveillance, including epidemiologic surveillance to monitor and determine the consequences of exposure to radiation of various population groups, including workers. (E.1c)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. The accident has shown that radiation protection, which has always been considered a "necessary evil" and secondary in importance to reactor operations and reactor safety, must be given a higher priority. At reactor sites, the radiation protection function should be made independent of operations and be elevated to equal importance. And the NRC should give greater emphasis in both its safety review and inspections to radiation protection. To do so, the NRC will have to acquire more expertise in this area. (p. 155)

REPORT OF THE SPECIAL REVIEW GROUP, OFFICE OF INSPECTION AND ENFORCEMENT, NRC (NUREG-0616)

1. Technical specifications should be amended to require a technical audit of radiation protection, chemistry, and radwaste management programs at a frequency not to exceed three years. The audit team should include persons meeting ANSI N18.1-1971 "Selection and Training of Nuclear Power Plant Personnel" (or successor standard) qualification for radiation protection manager and radiochemist. (2.5.5.1)

2. A comprehensive review of health physics, chemistry, and radwaste management should be done by IE with NRR participation during the first year of plant operation. A similar review should be done at all operating plants. (2.5.5.2)

3. IE regional management should review the current radiation protection and radwaste management inspection programs to identify plants where increased inspection frequency is needed. Inspector resources should be increased to support an augmented inspection program. (2.5.5.4)

4. The "Codes and Standards Section," 10 CFR 50.55a, should be reviewed and updated to include applicable industry standards (American Concrete Institute, Institue of Electrical and Electronic Engineers, and others). This would transform some design criteria which are presently only commitments into regulatory requirements and would provide a solid base for more rigorous inspection. (2.6.1.2)

5. The NRC should require licensees to report revisions to the SAR on a periodic basis. Significant changes which affect safety should be reported when the proposed change is defined for NRR review. All changes should be promptly distributed to Regional offices. (2.6.1.3)

6. IE should participate with NRR in determining the acceptability of proposed licensee alternatives to regulatory guides. (2.6.1.4)

7. An NRC task force should take immediate steps to identify installed radiation monitoring/sampling systems as safety-related and to establish acceptance criteria for them, considering TMI experience. Considerations should include state-of-the-art data handling, the need for additional data display outside the control room, and the need for requiring automatic grab sampling capability on release paths. Impose these criteria as requirements on licensees. (2.6.1.5)

8. IE inspection guidance for the monitoring systems should include acceptance criteria. The system and all related calibration and release procedures should be examined before an operating license (OL) is issued. (2.6.1.6)

Task IV.A: Strengthen Enforcement Process

The objective is to substantially improve licensee awareness and attitude toward safety by vigorous enforcement of NRC rules. The two major aspects of this objective are as follows: (1) assess substantial penalties for licensee failure to report safety-related information or for violations of rules defining safety practices or conditions; (2) adopt criteria for revocation of licenses, sanctions short of revocation, such as probation, and safety violations that would require immediate plant, shutdown or other operational safeguards.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC		Industry		Begin	End
			1980	1981	1980	1981		
1. Seek Legislative Authority	2	-	1.7my	-	-	-	1980	1980
2. Revise Enforcement Policy	2	To be scheduled and assigned resources along with normal agency functions.						

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. The agency should be authorized and directed to assess substantial penalties for licensee failure to report new "safety-related" information or for violations of rules defining practices or conditions already known to be unsafe. (A.11c)

2. The agency should be directed to adopt criteria for revocation of licenses, sanctions short of revocation such as probationary status, and kinds of safety violations requiring immediate plant shutdown or other operational safeguards. (A.11F)

REPORT OF THE SPECIAL REVIEW GROUP, OFFICE OF INSPECTION AND ENFORCEMENT, NRC (NUREG-0616)

1. The enforcement program should be studied to: determine methods for increasing the effectiveness of enforcement actions or sanctions; improve the timeliness of communications and enforcement action transmittals to licensees; establish interfaces with licensees to assure licensee awareness of NRC concerns; and establish enforcement actions more directly correlated with the degree of safety concern. (2.8.1.1)

2. Enforcement policy should be reviewed with particular emphasis on IE:HQ and OELD interface to assure timely processing of escalated enforcement action. (2.8.1.2)

Task IV.8: Issuance of Instructions and Information to Licensees

The objective is to develop a more efficient and effective management method for issuing information and requirements to licensees to eliminate the duplication of staff effort for NRC and licensees. Provide an NRC-wide system for tracking safety issues and recommendations, including differing professional opinions.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC		Industry		Begin	End
			1980	1981	1980	1981		
1. Revise Practices for Issuance of Instructions and Information to Licensees	2	To be scheduled and assigned resources along with normal agency functions.						

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. The agency's authorization to make general rules affecting safety should:

    a. require the development of a public agenda according to which rules will be formulated;

    b. require the agency to set deadlines for resolving generic safety issues;

    c. require a periodic and systematic reevaluation of the agency's existing rules. (A.9)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. Important decisions that lead to the establishment of required safety levels should be promulgated by agency policy through a more open and definitive procedure. (p. 142)

Task IV.C: Extend Lessons Learned to Licensed Activities Other Than Power Reactors

The objective is to assure that the lessons learned from TMI are applied to other key NRC programs.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC		Industry		Begin	End
			1980	1981	1980	1981		
1. Extended Lessons Learned from TMI to Other NRC Programs	3	-	2my	-	-	-	1979	1980

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. Agency's inspection and enforcement functions must receive increased emphasis and improved management.

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. Steps should be taken to eliminate possible protracted public hearings on individual rules and to ensure that the amount of public input is appropriate to the substantive issues involved. For example, rulemaking can often be carried out by consideration of written comments, rather than through public hearings. (p. 142)

REPORT OF THE SPECIAL REVIEW GROUP, OFFICE OF INSPECTION AND ENFORCEMENT, NRC (NUREG 0616)

1. The SRG concurs and encourages ID participation in implementing the recommendations of NUREG 0535, "Review and Assessment of Packaging Requirements and Emergency Response to Transportation Accidents." (3.13.11.1)

2. The NRC should improve liaison with the States to ensure that State and local police understand notifications required for transportation accidents involving licensed material. Toward this end, NRC could provide, for distribution to State and local law enforcement agencies, cards or stickers, or information booklets containing NRC Regional telephone numbers. (3.13.11.2)

Task IV.D: NRC Staff Training

The objective is to improve and expand the NRC training program for its technical staff, including supervisors, project engineers, inspectors, scientists, investigators, and safeguards personnel, including appropriate hands-on training.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC		Industry		Begin	End
			1980	1981	1980	1981		
1. NRC Staff Training	2	-	0.27my $197K	0.32my $187K	-	-	1980	1981

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. The responsibility at the federal level for radiological emergency planning, including planning for coping with radiological releases, should rest with FEMA. In this process, FEMA should consult with other agencies, including the restructured NRC and the appropriate health and envirnomental agencies. (F.1b)

2. Plans for providing federal technical support, such as radiological monitoring, should clearly specify the responsibilities of the various support agencies and the procedures by which those agencies provide assistance. Existing plans for the provision of federal assistance, particularly the Interagency Radiological Assistance Plan and the various memoranda of understanding among the agencies, should be reexamined and revised by the appropriate federal authorities in the light of the experience of the TMI accident, to provide for better coordination and more efficient federal support capability. (F.6)

3. The agency should be directed to require its enforcement personnel to perform improved inspection and auditing of licensee compliance with regulations and conduct major and unannounced on-site inspections of particular plants. (A.11d)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. One of the most glaring deficiencies in the NRC is the lack of a program for its staff to acquire experience in the actual design, construction, and operation of nuclear powerplants and of the problems of radiation protection. To regulate the safety of such plants effectively, the regulators should have a clear appreciation of the techniques and procedures used for design, construction, and operation. We recommend that the agency establish a policy that practical experience is a requisite for key staff personnel, and arrange an effective program to obtain this experience for the appropriate individuals. (p. 120)

Task IV.E: Safety Decision-Making

The objective is to develop plans for an integrated program of safety decision-making. These plans include (1) an expanded program of regulatory research covering methodologies for making safety decisions and safety-cost tradeoffs, with application both to decisions regarding the overall risk of nuclear powerplants and the nuclear fuel cycle and to specific licensing and inspection decisions; (2) early resolution of safety issues after they are identified, including application of the decisions to operating reactors, reactors under construction, and standard designs; (3) elimination of repetitive consideration of identical issues at several stages of the licensing process; (4) expanded use of rulemaking to implement safety criteria developed as a result of the various Task Action Plans; and (5) improved and expanded systematic assessments of operating reactors.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC		Industry		Begin	End
			1980	1981	1980	1981		
1. Expand Research on Quantification of Safety Decision-Making	3	To be scheduled and assigned resources along with normal agency functions.						
2. Plan for Early Resolution of Safety Issues	2	-	1.4my	-	-	-	1979	1980
3. Plan for Resolving Issues at Construction Permit Stage	3	-	-	-	-	-	-	1982
4. Resolve Generic Issues by Rulemaking	3	-	0.5my	0.7my	-	-	1980	1981
5. Assess Currently Operating Reactors	1	-	0.9my	-	-	-	1979	1980

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. Included in the agency's general substantive charge should be the requirement to establish and explain safety-cost trade-offs; where additional safety improvements are not clearly outweighed by cost considerations, there should be a presumption in favor of the safety change. Transfers of statutory jurisdiction from the NRC should be preceded by a review to identify and remove any unnecessary responsibilities that are not germaine to safety. There should also be emphasis on the relationship of the new agency's safety activities to related activities of other agencies. (A.4)

2. Licensing procedures should foster early and meaningful resolution of safety issues before major financial commitments in construction can occur. (A.10)

3. There should be an improved program for the systematic safety evaluation of currently operating plants, in order to assess compliance with current requirements, to assess the need to make new requirements retroactive to older plants, and to identify new safety issues. (A.11a)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. We were not asked, and it is not our place to tell the public, "how safe is safe enough." Indeed, as we make clear in this report, we believe this is a decision that in the final analysis should not be the exclusive province of the NRC: it is an executive decision that should be made as a part of our national energy strategy by the Executive and by Congress. The NRC cannot continue to face, sub silentio, in every policy and licensing determination the question of the future of nuclear power in this country. It is, lest we forget, an inherently dangerous activity that Congress has authorized the NRC to license. (p. 91)

2. We believe that standard designs for reactor systems, for the "balance of plant" and for control rooms should in the long run substantially improve plant safety and reliability. In our view, use of the NRC's standardization options should be required of all future applicants unless the Commission or Administrator grants an exception for good cause. (p. 144)

3. We do not suggest here that the existing safety review process be immediately supplanted by a more probabilistic review. What we are suggesting is that it be augmented, and that quantitative methods be used as the best available guide to which assicdents are the important ones, and which approaches are best for reducing their probability or their consequences. (p. 151)

4. Expand the spectrum of design basis accidents used for safety assessment purposes by using operational experience, research results, lessons learned from accidents, and advice from the ACRS, all studied through quantitative risk analysis.

Include the effects of multiple equipment and human failures where the risk of occurrence is significantly high.

Provide a risk-related scheme for classifying equipment on the basis of safety significance.

Include human factors considerations and operational procedures in the review process.

On a selective basis, determine whether some design features to mitigate the effects of some Class Nine accidents should be required. (p. 151)

5. Generic safety issues and other important policy issues should be handled by the agency or the Commission directly, through rulemaking and policy directives. (p. 142)

6. Steps should be taken to eliminate possible protracted public hearings on individual rules and to ensure that the amount of public input is appropriate to the substantive issues involved. For example, rulemaking can often be carried out by consideration of written comments, rather than through public hearings. (p. 142)

Task IV.F: Financial Disincentives To Safety

The objective is to enhance public safety through the reduction of disincentives to safety resulting from financial pressures on the utility at the construction, operation, and decommissioning stages.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC		Industry		Begin	End
			1980	1981	1980	1981		
1. Increased IE Scrutiny of Power Ascension Test Program	3	-	0.1my	0.2my	-	-	Conform to plant startup	
2. Evaluate the Impacts of Financial Disincentives to the Safety of Nuclear Power Plants	3	-	0.5my	-	-	-	1980	1980

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. Responsibility and accountability for safe power plant operations, including the management of a plant during an accident, should be placed on the licensee in all circumstances. It is therefore necessary to assure that licensees are competent to discharge this responsibility. To assure this competency, and in light of our findings regarding Metropolitan Edison, we recommend that the agency establish and enforce higher organizational and management standards for licensees. Particular attention should be given to such matters as the following: integration of decision-making in any organization licensed to construct or operate a plant; kinds of expertise that must be within the organization; financial capability; quality assurance programs; operator and supervisor practices and their periodic reevaluation; plant surveillance and maintenance practices; and requirements for the analysis and reporting of unusual events. (A.5)

2. Utility rate-making agencies should recognize that implementation of new safety measures can be inhibited by delay or failure to include the costs of such measures in the utility rate base. The Commission, therefore, recommends that state rate-making agencies give explicit attention to the safety implications of rate-making when they consider costs based on "safety-related" changes. (B.6)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. To deal with some of the financial disincentives to safety, the NRC will have to become more aware of the relationship between the business and technical sides of the utility. Once again, it will have to be more conscious of utility management. We suggest that consideration should be given to an expanded financial analysis of utility licensees so that the NRC might be alerted when financial pressures combine to affect safety. At the same time, the agency needs to improve its method of notifying other regulatory bodies of the effect their regulatory programs have on the overall safety of nuclear plants. (p. 164)

Task IV.G: Improve Safety Rulemaking Procedures

The objective is to improve NRC's rulemaking procedures to provide a meaningful opportunity for public participation, to assure a periodic and systematic reevaluation of NRC's rules, and to include appropriate provision for backfitting in all new regulations. (Item V.12 discusses related action assessing the delegation of rulemaking authority to members of the staff.)

ACTION ITEMS	PRIORITY		ESTIMATED COST		SCHEDULE	
	NRC's	Industry's	NRC 1980 - 1981	Industry 1980 - 1981	Begin	End
1. Develop a Public Agenda for Rulemaking	To be scheduled and assigned resources along with normal agency functions.					
2. Periodic and Systematic Reevaluation of Existing Rules	To be scheduled and assigned resources along with normal agency functions.					
3. Improve Rulemaking Procedures	To be scheduled and assigned resources along with normal agency functions.					
4. Study Alternatives for Improved Rulemaking Process	To be scheduled and assigned resources along with normal agency functions.					

RECOMMENDATIONS

PRESIDENT'S COMMISSION REPORT

1. Require the development of a public agenda according to which rules will be formulated. (A.9a)

2. Require a periodic and systematic reevaluation of the agency's existing rules. (A.9c)

3. Define rulemaking procedures designed to create a process that provides a meaningful opportunity for participation by interested persons, that ensures careful consideration and explanation of rules adopted by the agency, and that includes appropriate provision for the application of new rules to existing plants. In particular, the agency should: accompany newly proposed rules with an analysis of the issues they raise and provide an indication of the technical materials that are relevant; provide a sufficient opportunity for interested persons to evaluate and rebut materials relied on by the agency or submitted by others; explain its final rules fully, including responses to principal comments by the public, the ACRS, and other agencies on proposed rules; impose when necessary special interim safeguards for operating plants affected by generic safety rulemaking; and conduct systematic reviews of operating plants to assess the need for retroactive application of new safety requirements. (A.9d)

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. The Appeal Board, which was orginally intended to help coordinate consideration of generic issues, has for a good many years spent a substantial amount of its time and effort on procedural issues and in trying to interpret the Commission's substantive regulations and apply them to the facts in particular cases. The Board (and others) have pointed out that many of these regulations are vague, inartfully drafted, and even in some instances totally incomprehensible. Other regulations have significant gaps. We believe that the Appeal Board should not, by default of the Commission, have to continue to interpret, "improve" and apply ambiguous standards. (p. 140)

2. We believe the ACRS should be retained and its role strengthened by relieving the requirement that it advise the Commission on every license application, by encouraging it to play a more formal role as a party in licensing and rule-making proceedings, and by upgrading its staff. (p. 140)

3. Generic safety issues and other important policy issues should be handled by the head of the agnecy or the Commission directly, through rulemaking and policy directives, with the direct input of the staff, the ACRS, and intervenors. In particular, basic policy decisions having a primary impact on the level of safety provided to the public against the risks associated with nuclear powerplants, which are now made at various agency management levels, should be implemented through the rulemaking process. (p. 142)

4. Important decisions that lead to the establishment of required safety levels for the nuclear industry in this country should be promulgated as agency policy through a more open and definitive procedure. (p. 142)

Task V: NRC Policy, Organization and Management

The objective is to further delineate substantive safety policy by NRC and strengthen organization and management within the agency. The Commissioners propose to address the substance of these recommendations as indicated in the items below. The timing for each item depends upon the Commissioners' decisions; therefore, no time schedule is set forth.

ACTION ITEMS	PRIORITY		ESTIMATED COST				SCHEDULE	
	NRC's	Industry's	NRC 1980	NRC 1981	Industry 1980	Industry 1981	Begin	End
1. Develop NRC Policy Statement on Safety	N/A	-	To be determined		-	-	To be determined by the Commission	
2. Study Elimination of Nonsafety Responsibilities	N/A	-	To be determined		-	-		•
3. Strengthen Role of ACRS	N/A	-	To be determined		-	-		•
4. Study Need for Additional Advisory Committees	N/A	-	2my		-	-		•
5. Improve Public and Intervenor Participation in Hearing Process	N/A	-	1-2my		-	-		•
6. Study Construction-During-Adjudication Rules	N/A	-	1my		-	-		•
7. Study Need for TMI-Related Legislation	N/A	-	1-2my		-	-		•
8. Study the Need to Establish an Independent Nuclear Safety Board	N/A	-	1-3my	-	-	-	•	
9. Study the Reform of the Licensing Process	N/A	-	1-3my	-	-	-	•	
10. Study NRC Top Management Structure and Process	N/A	-	.1my	.1my $300K	-	-	•	
11. Reexamine Organization and Functions of NRC Offices	N/A	-	$200K $500K	-	-	-	•	
12. Revise Delegations of Authority to Staff	N/A	-	To be determined		-	-	•	
13. Clarify and Strengthen and Respective Roles of Chairman, Commission, and EDO	N/A	-	.3my	-	-	-	•	
14. Authority to Delegate Emergency Response Functions to a Single Commissioner	N/A	-	.6my	-	-	-	•	
15. Achieve Single Location - Long-term	N/A	-	4my	4my	-	-	•	•
16. Achieve Single Location - Interim	N/A	-	2my	2my $525K	-	-	•	
17. Reexamine Commission Role in Adjudication	N/A	-	1.8my	-	-	-	•	

RECOMMENDATIONS

THREE MILE ISLAND--A REPORT TO THE COMMISSIONERS AND TO THE PUBLIC (ROGOVIN)

1. The NRC would be wise to suspend processing of applications for Construction Permits and Limited Work Authorizations until it considers the various recommendations we have made for reforming the licensing process and for increased standardization. (p. 92)

2. Changes will require new legislation, executive reorganization, and substantial overhaul of the way the NRC is organized and managed, at the very least. (p. 92)

3. Present NRC staff functions devoted to performing quantitative risk assessment or reactors should be relocated in AEOD. (p. 98)

4. All the agency's resources related to montoring operating reactors should be consolidated in a single office, probably the current Office of Inspection and Enforcement. The basic design approval function should remain in NRR. Mechanisms should be developed for better coordination between licensing and operation monitoring offices of the NRC, including strong project management teams to monitor construction and testing of new reactors that have ties to both offices. (p. 99)

5. There is a clear and pressing need for an independent organizational entity with the agency that will be responsible for observing, evaluating and making recommendations to improve the quality of the overall performance of the regulatory staff. This need can best be satisfied by the establishment of an independent Nuclear Safety Board. (p. 118)

6. The Board should be composed of a number of persons who are trained in technical disciplines associated with nuclear safety and radiation protection and who are thoroughly experienced with the licensing and regulatory process.

7. Present NRC responsibilities that do not relate to radiological health and safety should be considered for possible transfer to appropriate agencies. Examples are antitrust responsibilities and jurisdiction over export licenses. (p. 121)

8. We recommend that high priority be given to locating the entire agency in a single location. In the interim, the offices of the Commissioners and their personal staff should be promptly relocated in Bethesda, Maryland. (p. 117)

9. The Executive Managment Team (EMT) should have a single director who should exercise the authority of the entire agency during an emergency. (p. 134)

10. The ACRS has a distinct role to play in the regulation process and that role should be strengthened. (p. 119)

11. The Nuclear Safety Board might be composed of five full-time members who would also be members of the ACRS. The ACRS would be composed of these five members plus 10 part-time members. (p. 119)

12. Additional staff should be provided to the ACRS. This recommendation could be met by having the Nuclear Safety Board staff provide support for the ACRS. (p. 119)

13. The ACRS's role should be strengthened by removing the requirement that it advise the Commission on every license application, encouraging it to play a more formal role as a party in licensing and rulemaking proceedings, and by upgrading its staff. (p. 140)

14. The ACRS's independence could be enhanced by decreasing the tremendous time commitment required, so that membership can be offered to individuals who cannot afford to devote half or more of their time to the ACRS. (p. 140)

15. The ex-parte rule should be very significantly limited and applied more rationally. Commissioners should become involved in safety issues pending in particular cases, as long as their involvement is on the record. (p. 141)

16. The two-step licensing process should be abolished for nuclear plants of conventional design. Instead, a single licensing review should be held prior to construction. (p. 141)

17. Once a license is granted, jurisdiction to oversee construction and confirm that the plant is constructed and and consistent with the design plans should be placed in the NRC staff. (p. 141)

18. If the Commission is replaced, the Atomic Safety and Licensing Appeal Board's decisions on granting a license should be final and any appeal from the Appeal Board should be made directly to the Federal Court. (p. 141)

19. If the Commission is retained, consideration should be given to abolishing the Licensing Appeal Board and requiring the Commission to consider and approve every new reactor license. Appeal Board members could be transferred to a support office to assist the Commission in this work. (p. 142)

20. An Office of Public Counsel should be established reporting to the head of the agency. The primary functions of the office should be to: (1) provide a source of legal and technical counsel to potential or actual intervenors and to public interest groups; (2) intervene as a party directly in agency rulemaking or licensing proceedings when appropriate; (3) fund and monitor, where appropriate, independent technical peer reviews; and (4) handle details of intervenor financing. (p. 143)

21. A program of funding of individual intervenors or groups of intervenors should be adopted for both licensing and rulemaking proceedings, administered through the Office of Public Counsel. (p. 143)

22. Strict requirements should be established that funding be conditioned upon the intervenor propounding non-frivolous issues that are not being effectively advanced by others. (p. 144)

23. Funding should be appropriate to the effort necessary with the final decision in reimbursement being made by the Office of Public Counsel, the Licensing Board, or (in rulemaking proceedings) by the Commissioner or Administrator. (p. 144)

24. Use of standardized designs should be required for all future applications, unless the Commission or Administrator grants an exemption for good cause. (p. 144)

25. Once a standard model plant is under construction, it should be treated by the NRC as if it were already in operation for purposes of deciding whether new design changes should be required. If a design change were clearly needed to make operating reactors safe, then the change should also be made on those "standard models" under construction. (p. 148)

26. The best way to improve on the existing design review process is to place increasing reliance upon quantitative risk analysis, emphasizing those accident sequences that contribute significantly to risk. We do not suggest that the existing safety review process be supplanted immediately by a more probabilistic review. This will be a long process, but the present review process should be augmented and quantitative methods used as the best available guide to which accidents are the important ones, and which approaches are best for reducing their probability or their consequences. (p. 150)

REPORT OF THE SPECIAL REVIEW GROUP, OFFICE OF INSPECTION AND ENFORCEMENT, NRC (NUREG 0616)

1. Joint IE/NRR review groups should be used to evaluate safety-related issues identified by IE. (2.3.1.1)

2. IE and NRR should establish an ad hoc committee to define the mechanism for effecting the above recommendation. The committee should also examine the current systems for information exchange between the two offices and recommend changes for improvement. (2.3.1.2)

3. The IE/NRR interfacing should include more interaction between NRR Project Managers and reviewers and IE inspectors. An interoffice agreement on joint IE/NRR site reviews should be implemented. (2.3.1.3)

4. The SRG believes that procedures should be developed to provide for automatic rereview of field identified safety issues which have been rejected within IE. Consideration should be given to having this rereview performed by a joint IE/NRR committee. (2.3.2)

5. IE should participate with NRR is determining the acceptability of proposed licensee alternatives to regulatory guides. (2.6.1.4)

[illegible]

3. It and TAR should establish [illegible] to define the mechanism for effecting the above recommendation. [illegible]

4. The [illegible] should include [illegible]

5. The SRC believes that [illegible]

6. It should particularly [illegible]

[illegible]

Chapter 5

Evaluation of Operating Experience at Nuclear Powerplants

By

Monte Simpson

INTRODUCTION

Evaluation of specific operating problems at nuclear power plants dates back to 1963, during the early years of the civilian nuclear energy program. However, in general the NRC's treatment of operating problems has been unsystematic, and there has been little assurance of a formal NRC response in terms of mandatory corrective actions to deal with identified problems.

Evaluation of operating experience at nuclear reactors entails the review of incidents at licensed nuclear power plants in order to identify significant safety aspects that should be corrected to improve operational safety. It is essential to the safety of nuclear power. The types of issues that can surface through evaluation of operations at nuclear facilities are numerous and varied. They include system design, operating procedures, information flow, operator training, interaction of plant personnel and equipment, human factors, management and the influence of regulations on the nuclear power industry.

Evaluation may be short-term or long-term. By monitoring plant operations over time, trends become apparent. It is long-term analysis that most often produces knowledge of universal or "generic" problems common to a type of power plant, or perhaps to all power plants. (1)

There are several components to evaluation of data on operations. The key ones are collection and analysis of data, recommendations or requirements as to corrective actions and dissemination of findings in a form useful to the nuclear power industry. (2)

CRITICISM OF THE NRC'S EVALUATION PROGRAM

After the TMI-2 accident, the NRC's approach to reviewing and responding to power plant operations received substantial criticism. The President's Commission on the Accident at Three Mile Island, (3) the Nuclear Regulatory Commission Special Inquiry Group, (4) and the Special Investigation of the Senate Subcommittee on Nuclear Regulation all found deficiencies. (5)

The report of the NRC Special Inquiry Group stated:

> . . . the NRC devotes proportionally far more of its talent and a higher priority to the review and analysis of reactor design than to reactor operations . . . Large reactors are now a "maturing" technology. Yet the NRC's emphasis on design review continues—due perhaps to congressional failure to revise the agency's original statutory mandate that focuses on licensing, but due also, we believe, to inertia and lack of leadership on the part of the NRC. (6)

The President's Commission report addressed the NRC's response to known safety problems.

> [The] NRC's primary focus is on licensing and insufficient attention has been paid to the ongoing process of assuring nuclear safety. . . . The old AEC attitude is . . . evident in reluctance to apply new safety standards to previously licensed plants. While we would accept a need for reasonable timetables for "backfitting," [[1]] we did not find evidence that the need for improvement of older plants was systematically considered prior to Three Mile Island. (7)

The Special Investigation found:

> b. Both the reactor-vendor, Babcock & Wilcox (B&W), and the NRC had programs for evaluating and acting upon individual problems occurring at nuclear power plants. However, the responses of the reactor-vendor and the NRC to these similar accidents suggest that neither had procedures to assure an effective systematic review and analysis of potentially recurring problems. For these reasons, TMI control room personnel did not have the benefit of analysis and guidance, based on similar accidents, that would have helped them in diagnosing and responding correctly to the early events of the accident on March 28.

Internal investigation within the NRC also revealed weaknesses in the agency's use of plant operations data. Both the Advisory Committee on Reactor Safeguards (ACRS)[2] and a special NRC investigative post-TMI task force[3] looked into the issue. (8) Both groups concluded that inadequate methods and procedures for systematically evaluating nuclear operations information were still the weakest aspects of the program for evaluating operating experience.

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[1] The modification of a reactor to satisfy a safety need identified subsequent to issuance of its Operating License.

[2] A committee of nuclear specialists that independently reviews and advises the Commission on nuclear safety studies and power plant license applications. ACRS also advises the Commission on special nuclear safety issues.

[3] The Lessons Learned Task Force was a group of representatives from the major NRC program offices assigned the task of reviewing the agency's programs and procedures for evaluating and analyzing operating data at nuclear plants. The task force was to make recommendations to the Commission for improving NRC's programs.

The report of the task force to the Commission noted:

> The major deficiency in current NRC activities associated with operational data is the ad hoc manner in which most activities are performed.
>
> The key element missing from NRC activities is a structured and systematic analysis of operational data. (9)

The ACRS offered a number of recommendations. Two were:

> a. That the adequacy and completeness of the format for submitting LERs [Licensee Event Reports [4]] be thoroughly reviewed . . . Attention should also be directed to the incorporation into the LER of a clear statement as to exactly what happened, the number of times a similar event has occurred in the past, its potential for recurrence, its significance relative to safety, and its implications relative to any design, maintenance and operational changes that may be required or are suggested by the given event . . .
>
> b. That a systematic procedure be developed so that the benefits or lessons to be learned from LERs submitted by individual licensees are fed back into the training programs for personnel involved in the design, construction, operation, and maintenance of all nuclear power plants. (10)

The NRC task force recommended that new organizational units be established within the NRC to give special attention to evaluation of data on plant operations. (11)

THE NRC'S RESPONSE

The Commissioners responded on July 12, 1979 by mandating an agencywide program for "systematic evaluation" of nuclear power plant operations. During the past year, the basic framework for this program has been established. An entirely new office has been created, the Office of Analysis and Evaluation of Operational Data. Other groups have been established within major existing offices, including one in the Office of Nuclear Reactor Regulation and one in the Office of Inspection and Enforcement. The AEOD was assigned the task of coordinating the NRC's program for evaluating data on operations.

The new NRC program is still in a preliminary stage of formulation and implementation. As of June 1980, only one agreement governing procedures between AEOD and the other groups had been worked out. Much work remains to be done before the program can become operationally effective.

THE INDUSTRY ROLE

Evaluation of operating experience is also carried out by the nuclear power industry.[5] The NRC is discussing the extent to which the agency should use industry programs already in existence or now being developed. Past experience has demonstrated that the nuclear industry is reluctant to have the NRC intervene in its data analysis programs.[6]

ORIGIN AND OBJECTIVES OF THE STUDY

The NRC, in its role as the regulator of nuclear energy, is responsible for assuring that operations evaluation addresses nuclear power safety effectively. This study on the NRC's programs and plans for evaluating and responding to operating data from nuclear power plants was undertaken in response to the serious concerns raised by the various investigations.

The objectives of the study were first, to examine the NRC's plans and programs for evaluating events and accidents at operating nuclear power plants and for implementing safety measures in response to lessons learned from problems with power plant operations; and, second, to provide recommendations to assist the Senate Subcommittee on Nuclear Regulation in carrying out its oversight responsibility.

As many of the NRC's new activities are still in the early stages, the focus of this study was on developing an overview of the NRC's past and present efforts and on identifying potential issues and problems. The study was derived from reports, correspondence and documents [7] and from interviews with NRC officials.

The next section discusses historical aspects of NRC programs to evaluate operating experience, prior to the TMI accident. The second section elaborates on the NRC's immediate post-TMI response to operations evaluation deficiencies and summarizes some of the important developments in the NRC's program over the past year. A third section contains a general analysis of the study's findings. The report concludes with recommendations.

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[4] A report that a licensee must submit to the NRC when an audit or a specified type of incident occurs at its nuclear facility.

[5] For information on industry activities, see Part II on the Nuclear Power Industry.

[6] See p. 311.

[7] See "References," pp. 321ff.

BACKGROUND

THE NRC'S PROGRAM BEFORE TMI

A formal program to evaluate operating experience at nuclear reactors was non-existent within the AEC until 1972, when the Office of Operations Evaluation was set up. It was established on the basis of recommendations from two studies, one undertaken by an assistant to one of the Commissioners, the other by Arthur D. Little Company under contract with the AEC. (12)

The Operations Evaluation Office was part of the Inspection Group in the Reactor Licensing Division of the AEC. When it was first created, it had three full-time staff members, paralleling its three basic functions: (13)

(1) Collection and dissemination of Licensee Event Report (LER) data;

(2) Evaluation of that data; and

(3) Development of probabilistic risk assessment [8] models for evaluating operations safety.

By 1974, the Operations Evaluation staff had increased to about 25. In the opinion of the group's original director, Peter Morris, his office had accomplished the following by that time: (14)

(1) Formalized the LER system, which previously had been relatively informal;

(2) Collected operating experience data for the period prior to establishment of the office;

(3) Instituted Regulatory Guide 1.61, which specifies the reporting requirements for licensees;

(4) Instituted the "rainbow" books, such as the Grey Book, which summarize information on operations for all power plants over specified periods of time and which are disseminated to the nuclear power industry; and

(5) Wrote several reports based on the office's analyses of operating experience.

In an interview with Special Investigation staff, Morris said that during his tenure there were problems in getting the regulatory office in the AEC, the Division of Operating Reactors, to agree with his office's recommendations for action, which were based on findings from evaluating data on operations.

Morris left the AEC in November 1975, and in that year after the NRC was established by the Energy Reorganization Act, the office was disbanded. (15)

Morris said when the office broke up, its staff and functions were divided among several offices. He thought that most of the ongoing evaluations were taken over by two staff members in the Office of Management and Program Analysis. (16)

Prior to the accident at TMI-2, the NRC program for evaluating operating experience is as follows. A total of 44 people in the NRC and the Advisory Committee on Reactor Safeguards (ACRS) were on the distribution list for Licensee Event Reports (LERs). These people were scattered throughout the agency. Of the 22 agency offices, divisions, branches and special groups that reviewed LERs, 18 of these 22 offices had only 1 person assigned to LER reviews. The remaining 4 offices had more than 1 staff person assigned to LER review. Of the five major program offices under the Executive Director for Operations, before the TMI accident, only two had formal procedures for data collection and analysis.

At the time of the TMI accident, consultants were conducting special case studies in data analysis as well as studying methods of collecting and evaluating operational data. Five such studies under contract with the NRC were budgeted for $750,000 in 1979.

DATA ACQUISITION

Licensee Event Reports

The NRC collects information on operating experience in a variety of forms. The primary source pertaining to accidents and problems with reactor operations has long been the Licensee Event Report (LER). Regulatory Guide 1.16, "Reporting of Operating Information Appendix A Technical Specifications," outlines the licensees' responsibility to report certain safety-related operating events through LERs and states that the requirements for LERs and for monitoring nuclear facilities will be outlined in the Technical Specifications [9] for each plant. Technical specifications, developed uniquely for each plant as part of its licensing restrictions, have become progressively more voluminous over the years.

One result has been a lack of uniformity in reporting on and monitoring of mechanical systems at different power plants. (17) For example, a report from the GAO (18) noted that an NRC comparison of reporting and surveillances at power plants showed that a plant licensed in 1970 was only required to undertake 13,633 annual surveillances, whereas a plant licensed in 1977 was required to make 169,216. Plants licensed before 1970 submitted an average of 29 LERs annually, whereas plants licensed in 1976 submitted an average of 99. (19) The agency concluded,

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[8] Mathematical models of real-world systems that calculate predictively the reliability and safety of a system and the probability of an accident of a certain type occurring.

[9] The conditions and requirements according to which the NRC permits a plant to be operated.

> We find it paradoxical that NRC imposes its most stringent surveillance and reporting requirements on utilities operating newer powerplants. These newer plants incorporate the latest technological improvements and NRC safety requirements and presumably are safer to operate than older generation plants. It seems, therefore, that the more stringent requirements for newer power plants should logically also fall on the older powerplants. (20)

The Advisory Committee on Reactor Safeguards Report

In December 1978, the Advisory Committee on Reactor Safeguards (ACRS) had begun a study on the usefulness of the information in LERs. It was undertaken in response to a request by the Chairman of the NRC, a letter from Congressman Morris K. Udall and a suggestion by Dr. Harold Lewis of the University of California (Santa Barbara) Physics Department. Fifteen consultants worked with the 11-member subcommittee of the ACRS responsible for the study. (21)

The ACRS study focused primarily on a review of 8,700 LERs that had been reported between 1976 and 1978. Quarterly NRC reports to Congress were also reviewed, but they were found to contribute less to the study's findings. In addition to studying the LERs, the ACRS Subcommittee also reviewed summary reports on licensee events prepared by the NRC and the industry. Interviews and meetings were held with representatives of the NRC, utilities and nuclear safety specialists. (22) To expedite review of the information, the LERs were grouped by type of component and system involved.

The ACRS found that the LERs could be categorized according to three major levels of significance: (23)

(1) Events having serious safety implications.

(2) Events of concern, but only tangentially related to safety.

(3) Events that were not pertinent to safety, but that occurred with a high frequency.

Eleven types of serious safety events were identified, including the unavailability of vital services,[10] systems interactions,[11] valve failures,[12] loss of containment isolation[13] and human interruption of engineered safety features.[14]

The ACRS noted:

> Human errors in the design, operation, and maintenance of reactor components and systems represent a significant source of LERs. Up 50% of all failures appear to be attributable to this source. Contributing factors include the use of inadequate instructions, procedures and/or guides; a lack of adequate attention to man/machine interfaces so as to reduce the probability of error; and the use of improperly trained personnel. (24)

The ACRS also commented on the utilities' view of reportable events in relation to LERs: "licensees stated that at least twice as many events were judged to be worthy of note as were reported to the NRC in LERs according to its requirements." (25)

The ACRS issued its findings in September 1979 (subsequent to the TMI accident). It suggested that given current demand for energy and the world situation, both the industry and the NRC should research and resolve safety problems of the scale that were being identified by the LERs, if only to avoid the excessive down-time at nuclear plants. (26) The report criticized the NRC for not giving the LERs adequate attention and that, as a result, the real root causes of reactor incidents were often overlooked. (27)

The ACRS offered several recommendations, among them that:

- The NRC define more clearly the objectives of the LER system; (28)
- Events attributed to human error be closely investigated for underlying causes beyond the human element; (29)
- The format of LER reports be reviewed and reflect better the systems involved in the event as a safety concern, and design, maintenance and operational changes resulting from it; (30)
- No restrictions or limitations be placed on the number of LERs reported, merely to ease the burden on the NRC of having to conduct more thorough reviews of LERs. (31)

Prior to the accident at TMI, the NRC had indicated it would attempt to standardize reporting requirements for plants to be licensed in the future. (32) As of June 1980, the subject was still under review in the Office of Nuclear Reactor Regulation[15] at the NRC, which is conducting a study funded through 1982. The current operating budget for the study is $1,300,000 for fiscal year 1980. (33) Also as of June 1980, the NRC had not committed itself to upgrading the reporting requirements of older plants.

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[10] Such as the heat removal systems.

[11] Refers to the failure of one system which causes failure(s) in other systems.

[12] Includes leakage and failure of a valve to open or close on command by the operator.

[13] Failure of systems to isolate and prevent radiation from escaping the reactor.

[14] Such as operators' overriding automatic safety systems, as happened with the Emergency Core Cooling System at Three Mile Island.

[15] See Appendix B, "Nuclear Regulatory Commission Organization," for details on the various units within the NRC.

Nuclear Plant Reliability Data System

In addition to its own data gathering systems, the NRC has had access to information sources established by industry. One is the Nuclear Plant Reliability Data System (NPRDS), founded by the Edison Electric Institute in 1973. NPRDS is run by a private contractor and is overseen by a subcommittee of the American National Standards Institute (ANSI).[16] The NRC provides about $150,000 of the $370,000 operating budget for the system; the balance comes from industry. (34) Fifty-five of 58 eligible plants were participating in NPRDS at the time the GAO report was written. However, the NRC estimated that even participating plants were only submitting about 65 percent of the data (35) they could. (36) Its data is specific to system and component failures. (37)

The NRC has been using NPRDS data for reliability studies on power plant components and systems; these are conducted by its Office of Research.

In his April 1977 energy message, the President requested mandatory participation by utilities in the NPRDS. The NRC has been undecided about the need for such an arrangement. An NRC study group issued a report in 1977 stating that there should be mandatory reporting. The same report also stated, however, that "mandatory reporting would not result in any major nuclear power plant design improvements." (38)

In August 1978, the NRC recommended that NPRDS reporting remain voluntary, pending further studies on the issue, and then allocated more funds to promote better voluntary reporting to the NPRDS. (39)

The ACRS, in a report, recommended against mandatory reporting to NRPDS based on (1) economics, (2) duplication of the NRC's LER system[17] and (3) the lack of effort by the NRC in analyzing the LERs already available. (40)

Some industry spokesmen have opposed the idea, claiming that reporting would open the door for excessive regulation and intervention by the NRC. (41)

At the time of the TMI accident, the NRC was still debating the issue of mandatory licensee reporting to the NPRDS.

DATA MANAGEMENT

One criterion for successful evaluation of plant operations is the availability of useful data. In addition, capabilities for handling and processing the data must be adequate. As with data acquisition, the AEC's and the NRC's programs also suffered from inadequate data management.

In 1962, the White House had conducted a study on the information explosion. In a paper on the study, it recommended more systematic processing of high technology information. The then-Assistant Director of the Division of Reactor Development and Technology in the AEC had responded by spearheading the establishment of the Nuclear Safety Information Center (NSIC) at the Oak Ridge National Laboratory (ORNL), operated by Union Carbide Company. (42)

The AEC and after it the NRC have been funding most of the NSIC program. In 1979 the NRC provided 85 percent of the support for the program, with the remaining 15 percent coming from the Department of Energy.

NSIC has been providing data management services to the NRC, the DOE, private industry and many other customers. NSIC clients may join solely in relation to a specific case or as an annual member. NSIC has about 1,300 annual members. (43)

When NSIC was established in 1963, most of the nuclear industry was government-owned and operated. The information NSIC collected came mostly from AEC facilities, and there was no formal LER system at the time.

As originally set up, NSIC was to collect, assemble and report on data pertaining to all types of nuclear issues—e.g., materials safety, reactor siting, and operational experiences at nuclear facilities. Over the years, however, the broad scope was narrowed to a focus on operational data from nuclear reports. (44)

Neither the NRC nor DOE has provided specific guidelines to NSIC on its operations. At the time of TMI,[18] NSIC received all the LERs from NRC headquarters approximately weekly. It logged the information on a computer data filing system. Since 1963, over 20,000 LERs have been filed. Notably, a large number of the LERs represented minor occurrences (for example, approximately 15 percent were reports of instrument drift[19] in reactor control rooms). (45)

NSIC has developed an in-house file of 3,200 key words. It codes the LER information by the key words before entering the material into the computer files. This has facilitated cross-referencing of LER data, and several of the major services NSIC provides to its customers use this cross-referencing capability extensively.

Because of resource limitations, NSIC has traditionally spent most of its effort cataloging, filing and assembling LER information on the computer system. Until recently, it was uncommon for NSIC to analyze the LER information to identify operating trends and safety implications. (46)

One NSIC service has been "retrospective searches," which entail a review of the entire NSIC data base for information regarding specific data, such as all events related to failure of a certain system, components or accident scenarios. Retrospective searches are commissioned case-by-case. NSIC has been averaging about 70 per month. (47)

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[16] A national organization that provides generally agreed upon standards for manufacturers, consumers and the general public, including standards affecting the nuclear industry.

[17] See p. 309.

[18] NSIC operations since TMI have remained basically the same.

[19] Refers to a miscalibrated instrument indicator, similar to a car speedometer that reads 100 mph when the car is actually traveling 120 mph.

NSIC provides another service, Selective Dissemination of Information (SDI), to its members on a regular bi-weekly basis. Each member submits to NSIC a list of several nuclear-related subjects of current interest. They are drawn from an NSIC list which includes, for example, reactor operational safety, reactor siting and plant design. NSIC keeps its members up-to-date by printing and mailing summaries of information on 5″x8″ postcards.

NSIC also issues monthly and annual reports to its primary contractors (NRC, DOE), with updates on general activities and findings. Occasionally it issues summary reports under a NUREG (NRC) code number.[20] (48)

In 1974 NSIC played a substantial role in helping NRC headquarters develop an in-house data management system for LERs similar to that at NSIC. The NRC system has always been located in the Licensee Operations Evaluation Branch (LOEB) under the Office of Management and Program Analysis (MPA). Unlike the NSIC files, the NRC headquarters system did not use keyword referencing, which has inhibited quick retrieval of filed information.

The Advisory Committee on Reactor Safeguards (ACRS) offered the following comments on the NRC data management system in its September 1979 report:

> The information retrieval system presently used by the NRC is insufficient and a better system should be developed. To this end the keyword scheme used by NSIC should be considered for incorporation into the present NRC system. The NSIC system is more easily understood by the user and appears to be more comprehensive. The next generation of information retrieval schemes might be a hybrid of the two present methods. (49)

The NRC Research Office has been using NSIC data for reliability and risk assessment studies, similar to the way it has been using reliability data from NPRDS.

REGULATORY RESPONSE TO OPERATING PROBLEMS

Once a generic safety problem was identified by the NRC, one of two basic steps was to be taken: (50)

> 1. Notices would be delivered to licensees requesting immediate correction of the problem or
> 2. The issue would be studied by the NRC to assess the level of safety and risk involved, with the objective of arriving at an optimum resolution of the problem.

The second course of action was typical of issues that might require sometimes costly backfitting of mechanical hardware, major corrective measures in operations procedures or changes in the plant regulations.

Prior to the TMI accident, the NRC's generic issues program in the Office of Nuclear Reactor Regulation was one means of responding to identified safety problems.

This program was developed in response to the following amendment to the Energy Reorganization Act of 1974, which was passed in 1978:

UNRESOLVED SAFETY ISSUES PLAN

> The Commission shall develop a plan providing for specification and analysis of unresolved safety issues relating to nuclear reactors and shall take such action as may be necessary to implement corrective measures with respect to such issues. Such plan shall be submitted to the Congress on or before January 1, 1978 and progress reports shall be included in the annual report of the Commission thereafter. (51)

The basic elements of the generic issues program are outlined in an NRC report, (52) "NRC Program for the Resolution of Generic Issues Related to Nuclear Power Plants." They are: (53)

1. Categorizing generic safety issues by priority with respect to safety significance (A,B,C,D). (General descriptions of each category are given in Appendix B of the generic issues program report.) The most important issues are in category A and involve:

   > Those generic technical activities judged by the staff to warrant priority attention in terms of manpower and/or funds to attain early resolution. These matters include those the resolution of which could (1) provide a significant increase in assurance of the health and safety of the public, or (2) have a significant impact upon the reactor licensing process. (54)

2. Establishment of technical steering committee to improve and coordinate management oversight of the operations evaluation program. (55)
3. Establishment of an advisory group for the technical steering committee, to be comprised of five senior technical staff representatives from each of the major divisions in the Office of Nuclear Reactor Regulation. (56)
4. Assignment of task managers to each generic issue under review. (57)

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[20] E.g., "Reactor Operating Experience," NUREG/CR-0369, 1975-1977.

5. Development of task action plans under the supervision of task managers, subject to review and approval by the program steering committee. (58)

6. Preparation of a monthly publication summarizing the progress and status of the generic safety issues program.

7. Provision to the public of documents on the generic issues task action plans. (59)

At the time the generic issues program report was written, several aspects of it were still under development: (60)

1. Nine of 41 class A generic issues had yet to acquire approval of a task action plan. (61)
2. Staffing by the Office of Nuclear Reactor Regulation was awaiting clear definition of task requirements. (62)
3. Refinement and implementation of the Management Information System was not complete. (63)

POST-TMI DEVELOPMENTS IN EVALUATION OF OPERATING EXPERIENCE

TASK FORCE STUDY

As noted, an internal NRC Lessons Learned Task Force was assembled immediately after the accident at TMI to study, among other things, the agency's problems with analysis of data on operations. The task force, in its report to the Commission, called for special attention and a policy commitment by the NRC to evaluation of operating experience. It stated:

> An important consideration in the evaluation of any options is the . . . qualifications of the individuals screening and analyzing the data . . . The broad technical expertise required to analyze the data will require that the very best people be utilized to staff that group. Otherwise, the significance of particular reports could be overlooked or a less effective recommendation made to the responsible offices . . . To be successful, improvements in the processing of the data must be actively supported by office and line management . . . Active interoffice cooperation and coordination will play a major role in the success of the program . . . A "business as usual" approach would most likely not result in the potential improvements in the evaluation of data or implementation of those results. (64)

After presenting its recommendations to the Commission, the task force studied 13 alternatives for an organized and "systematic" program for evaluating reactor operations information. The key variable among the alternatives was the degree to which the program should be consolidated under one director. The task force concluded:

> It was believed that a centralized effort for analysis and evaluation would tend to be more efficient than a dispersed effort. On the other hand, as the effort is more centralized, there would be a tendency for the centralized effort to overlap that analysis and evaluation that [is taking] place in the program offices, resulting in a potential net agency-wide loss in efficiency. (65)

COMMISSIONERS' RESPONSE

In response to the recommendations submitted by the post-TMI operation evaluation task force, the Commission approved the establishment of a central office within the agency to serve as the focal point for operations evaluation. In a memo dated July 1979 from the Commissioners to the Executive Director for Operations, the Commissioners stated:

> This is to advise you that the Commission has reviewed the subject paper and (with all Commissioners concurring) approves the creation of an agency-wide Operational Data Analysis and Evaluation Group reporting directly to you (Executive Director for Operations). The Commission believes that this agency-wide office should be responsible for analyzing and evaluating operational safety data associated with all NRC activities, including those of NMSS (Office of Nuclear Material Safety and Safeguards). Further, the individual program offices should also have an operational data analysis and evaluation capability. Such a capability would allow the individual program office to make input to the agency-wide office's evaluations, and perform special operational safety data analysis. (66)

In a separate memo, Commissioner Kennedy, among other things, commented:

> In carrying out its assigned responsibilities, the agency-wide office should also assume an oversight/peer review role with respect to the activities of the operational data base analysis review groups within the individual program offices. (67)

PROGRAM ORGANIZATION

Following the Commissioners' directive, various groups were created within the NRC to review operating experience at nuclear power reactors. Among them are:

(1) The Office of Analysis and Evaluation of Operating Data (AEOD). This new office is organizationally parallel to the main program offices of the NRC. It reports to the Executive Director for Operations.

(2) The Operating Experience Evalua-

tion Branch (OEEB)[21] within the Division of Safety Technology (DST) under the Office of Nuclear Reactor Regulation (NRR).

(3) The Operating Experience Analysis Branch (OEAB) in the Office of Inspection and Enforcement.

Other new programs were created within the Office of Nuclear Materials Safety and Safeguards, the Office of Research, the Office of Standards Development and the Office of International Programs. (68)

AEOD has drafted a procedures manual entitled "Operational Safety Data Review Procedures", which outlines the responsibilities of the various evaluation groups and specifies the methods of operation. It is pending approval. In addition to this procedures manual, AEOD is drafting agreements[22] governing the relationships among the groups. At present, it appears that the AEOD is to be responsible for facilitating and coordinating the various operations evaluation units within the program offices. As such, it is also to review the results of other groups and devise a means of assessing their performance. It will also document the status of reactor operations safety problems under review. (69)

The AEOD's draft manual on procedures states that "Regular periodic overview of the foregoing activities shall be conducted." (70) AEOD has, as noted, been designated to provide "oversight" over the agency's program. However, the manual does not explain how the overview is to be conducted or what authority the AEOD has over the program offices. It does state that "the ACRS (whose membership can provide an independent perspective) or the NRC management may be involved." (71)

None of the procedures or interface agreements had been formally adopted by the NRC as of mid-June, 1980. The only official procedures applicable to the agency-wide operations evaluation program were set forth in a two-page memo dated June 14, 1980 from the Executive Director for Operations to the major program offices (Analysis and Evaluation of Operating Data, Management and Program Analysis, Nuclear Reactor Regulation, and Inspection and Enforcement). (72)

The memo details eight interim procedures to ". . . facilitate AEOD reviews of operational data and to coordinate the activities of the NRC offices responsible for review of operational data. . . ." (73) These interim procedures are to provide guidance for the operations evaluation program until the AEOD's procedures manual, "Operational Safety Data Review Procedures," is approved.

SELECTED PROPOSALS TO IMPROVE DATA ACQUISITION

In interviews with NRC officials, the Special Investigation staff was told of several new proposals for data acquisition techniques. Perhaps the most controversial involves an incentive scheme that would reward plant personnel and the public for surfacing verifiable safety problems at power plants. Carl Berlinger, Branch Chief of the Operating Experience Evaluation Branch, said:

> . . . I am evaluating different ways of getting information. One . . . is the type of incentive program that would involve staff as well as people in the general public and industry where there could be periodic cash awards, . . . periodically we would review all the suggestions that have come in and give an award to the one which has made the largest contribution to the improvement of safety. (74)
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> * * * * *
>
> [The incentive program] would work internally as well as externally. It would be an incentive to people within NRC who have the philosophy that they want to look at events that occur to learn things from, but this is an additional incentive where they might be able to get a cash award. (75)

Berlinger contrasted the incentive plan with the current NRC practice of obtaining operations data through regulation and enforcement:

> . . . there has been a tendency in the recent past for punitive fines to be levied by I&E [Inspection and Enforcement]. I am not sure I agree with that approach. I think it is a disincentive for people to come to us, especially people who work at the utility or utility executives themselves. . . . (76)

He suggested, "It does a better service to remove the punitive damage type of approach and get cooperation." (77) According to Berlinger, the rationale for the incentive program was that it would gain greater cooperation from industry. (78)

However, another NRC official, Edward Jordan of the Office of Inspection and Enforcement, called the incentive system "ludicrous," based in part on past experience. (79) Further, he noted that utilities are not always penalized:

> As long as there is no significant event associated, normally it doesn't result in a fine. There is a recommendation of the licensee finding, identifying, and reporting . . . Where the licensee doesn't report, then that would be a basis for NRC taking stronger enforcement action. (80)

Jordan described means by which his office could obtain data during accidents, in keeping with its responsibility for immediate response to problems identified through operations evaluation. It involves direct transmission of data from power plants to the NRC via a data link that would measure key parameters indicating the physical status of the reactor. It can be used to provide important information to people at NRC headquarters during severe accidents that have a potential for excessive releases of radioactivity to the environment.[23]

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[21] The creation of OEEB in the NRR plan was contingent upon the adoption of a reorganizational proposal for the NRR, which was approved in April 1980. While the reorganization proposal was pending, NRR had set up an Operations Experience Evaluation Group to perform the evaluation tasks designated for OEEB.

[22] These agreements have been documented in preliminary form in some cases; they are known as "interface agreements."

The director of the AEOD, Carlyle Michelson, also has ideas for improving data collection. He believes the NRC and the nuclear industry should share that responsibility and set up a common data base that would consolidate the existing myriad sources of data, even more numerous since the TMI accident. He commented,

> . . . there should be no reason why the industry is using one set of data and we are using another. The LER is a LER, whatever it says, we ought to all be using the same one in the same form. (81)

He noted that the need for data was common to both the NRC and industry (82) and suggested,

> I am hoping that we can work with the industry . . . through the Nuclear Safety Analysis Center of EPRI and through the Institute of Nuclear Power Operations [24] to work at establishing a common data base. This would be a base that would be available to everybody, including the licensees. (83)

Michelson added that there would be limits to a joint NRC-industry program:

> . . . having established a mutual data base . . . now you set about trying to decide what it tells you. There is where you have to do your own thing. I don't believe that I could use the utility industry's evaluation as a basis for decision making any more than I would expect them to use my evaluation. I think we each have to look at the data ourselves . . . (84)

A NRC–NSIC TIE

Closer cooperation between the NRC and the NSIC could be one means of developing a common data base. Two officials from NSIC were invited to the NRC in November 1979 to brief NRC officials on NSIC's activities. At that time, the interim director of AEOD suggested that there may be a role for NSIC in the new NRC program for evaluating operating experience, but that a formal proposal would be deferred until the AEOD outlined its final objectives and was better established. (85)

In February Michelson commented on the preliminary status of his plan for a common data base:

> We are, again, just getting started. What we have done so far is I have had one meeting with . . . [Dr. Edwin Zebroski, Director of the Nuclear Safety Analysis Center] to discuss with him what are the common grounds that we could work on together. . . . (86)

ANALYSIS OF THE NRC OPERATIONS EVALUATION PROGRAM

ORGANIZATION

The evolving structure of operations evaluation suggests that a "turf battle" over responsibility for operations evaluation may occur—or already is occurring. When the NRC Task Force made its recommendations in June 1979, the Executive Director for Operations advised the Commissioners that the various staff offices concurred in the recommendation that a full-time agency-wide group be created to perform analyses and evaluation in "coordination with dedicated individual groups within the program offices." (87) However, the EDO also told the Commissioners that the staff offices were split over the proper placement of this new group within the NRC's organizational framework. The Office of Nuclear Reactor Regulation, for example, believed that the agency-wide group should report to its Director. The Office of Research disagreed, contending that the agency-wide group should be located outside the inspection and licensing operations in order to have the proper independence of views, skepticism and visibility. (88) The Office of Inspection and Enforcement was similarly "concerned with placing the agency-wide group under NRR," suggesting that the Office of Research or the Office of Standards Development should take the responsibility.

In creating the AEOD, the Commissioners rejected all of these staff suggestions. They made the new group reportable directly to the Executive Director for Operations, ignoring the EDO's own view that the NRR Director was the appropriate official to whom the group should report. (89) Thus, from the outset, staff offices have had differing opinions as to who should have immediate authority over the new agency-wide group.

There seem to be similar differences of opinion among staff as to the respective roles of the various newly-created evaluation groups. When interviewed in April 1980, Michelson described his view of the relationship between his new office, AEOD, and the units created within Inspection and Enforcement and Nuclear Reactor Regulation. He suggested that Inspection and Enforcement would be involved principally with immediate responses to problems:

> . . . they have to maintain a level of contact with operational data that permits them to make immediate decisions on perhaps the acceptability of a start-up again, or a requirement for a shutdown. (90)

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[23] For further details on the proposed Nuclear Data Link, see Part I, Chapter 1, p. 27.

[24] See Part II, Chapter 1, p. 325.

He said that Nuclear Reactor Regulation would be similarly involved because

> . . . when an event occurs, there is a question about compliance with technical specifications or maybe equipment is not working as described in the safety analysis reports or whatever. (91)

AEOD, on the other hand, would be

> . . . involved in the longer range. This office is not an immediate response office. (92)

Michelson explained that AEOD's role would not be regulatory or adversarial, but instead

> . . . [would be] looking at what the operational history is telling us, what may be the clouds on the horizon as a result of these experiences, but not reacting to the immediate, to a given event. (93)

Although Michelson's description suggested that the AEOD would bear responsibility for all long-range reviews of operating events by the NRC, the preliminary agreement[25] between his office and NRR suggests that both offices would be conducting these types of reviews:

> Both AEOD and NRR may screen operational data, both domestic and foreign, to identify safety concerns associated with a specific plant or of a generic nature. Reviews may be initiated by either office in order to assure an adequate understanding of the full significance and implications and to identify the appropriate extent of detailed engineering case studies that may be required. (94)

The potential for overlap between AEOD and NRR also was indicated by NRR at a presentation to the ACRS on April 22, 1980. At that time, it described its new responsibilities as including the following:

- Perform special studies of operating experience data in a specific area to resolve operating events or problems having safety significance. (95)
- Determine generic implications of operating experience and as necessary propose new generic safety issues. (96)
- Review of domestic and foreign reactor operating experiences to detect patterns in operational events or other operating experience. (97)
- Provide a central, visible organizational entity for the review and evaluation of recommendations made by other NRC offices and NRR branches, including specific followup action requirements and implementation schedules. (98)
- Maintain and improve requirements for reporting operational events or problems. (99)

All of these appear to overlap with the responsibilities of AEOD. Certainly, activities such as special studies and assessments of patterns revealed by operating data are far broader in scope than Michelson's description of NRR's "immediate response" role. The last task in particular—maintenance and improvement of reporting requirements—should logically fall under the auspices of the lead operations evaluation office, as it involves the data base, which is used by all operations evaluation units within the agency.[26]

The Office of Inspection and Enforcement (I&E) is less likely than either the Office of Nuclear Reactor Regulation or AEOD to become involved in long-term reviews of operating experience. Still, Edward Jordan, Director of I&E's Operations Evaluation and Analysis Branch, indicated that his group would be looking beyond violations or regulations to longer-term safety problems:

Jordan stated:

> The plan is really not to look so much at regulatory requirement in terms of fulfilling the tech spec [technical specifications] but in terms of safety problems. These are potential generic problems, design problems with specific facilities . . . so they are engineering problems . . . [more] than regulatory problems. (100)
>
> We are looking for safety problems more than violations of regulations because, obviously, if the licensee has reported it, he has already found out because the regulations require it to be reported. The actual violation of the procedure would be something that the regional office can and does handle without any further review from this [headquarters] office. We are trying to look at engineering problems to a greater extent. (101)

When asked if he meant long-term, Jordan replied:

> Yes . . . For the longer-term reviews we are sifting information and trying to find specific plant problems [and] generic technical issues, we are looking for safety problems more than violations of regulations. . . . (102)

Another potential problem with the present organizational network is the variety of pathways over which a problem can circulate through the NRC. This not only makes the evaluation program management task more difficult, but it also risks the chance of multiple and contradictory orders and statement emanating from the agencies. With so many people now giving deliberate attention to operations evaluation, the chances are great that a problem will travel along multiple paths, at least until the procedures for handling the data evaluation are further refined and implemented.

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[25] Written agreements between the AEOD and its constituent groups are to describe the roles and responsibilities of each. The interface agreements will supplement the procedures manual written by AEOD. At present, the only agreement that has been written is between the AEOD and the Office of Nuclear Reactor Regulation, and it is still in draft form.

In an April interview, NRR's Carl Berlinger said that AEOD would conduct "long-term" review of operational experience and that his group within NRR would be responsible for that area "[b]etween immediate response and the long-term study functions."

[26] See p. 313.

Licensees and other regulated parties have in fact complained that the NRC issues contradictory signals. Eisenhut, Director of the Division of Licensing in NRR, cited an example involving a steam generator problem at a particular facility. The NRR issued a corrective order to the plant, only to learn a few days later that the Office of Inspection and Enforcement had earlier reached an agreement with the licensee, prior to NRR's order. (103)

The Office of Nuclear Reactor Regulation is planning to assign personnel to the Office of Inspection and Enforcement field offices so that there will be channels by which licensees can communicate with it directly, eliminating I&E as middlemen. (104) This would give the two offices a degree of autonomy that conceivably could result in duplicative work or inconsistent directions to licensees.

In April the director of AEOD expressed to Special Investigation staff an interest in further consolidating some of the NRC's operations evaluation activities under his office in order to preclude difficulties in its management oversight task. (105)

The AEOD procedures manual already has been revised several times. Both it and the interface agreements have yet to be approved by the Commission. Once they are approved, the viability of the program will still be dependent on the manner in which they are implemented.

DATA ACQUISITION

As noted, for a number of years the NRC has been deliberating the issues both of mandatory reporting to the Nuclear Plant Reliability Data System and of upgrading reporting requirements for older plants.[27] The prolongation of these discussions indicates indecision within the agency regarding requirements and needs for data on plant operations.

Since TMI, no new methods of data acquisition have been implemented, and both the incentive program and the data link system are still under consideration.

The LER system is receiving the most attention as a source of operations data and is currently being reviewed by the NRC operations evaluation groups, with AEOD coordinating the effort. NRC staff have estimated that six months to a year will be necessary for determining what revisions are necessary. (106) One problem is that the type of analysis to be conducted has not been clarified; the data to be collected will have to be suitable for the analysis. The task force report to the Commission did propose an outline for data analysis. However, neither the interim procedures nor the preliminary procedures manual refer to specific analytical models or methods of data evaluation. Instead, there are general references to evaluation methods, such as the following interim procedure:

> AEOD should promptly inform NRR and I&E of any significant matters it identifies during the course of its data collections and assessment activities. (107)

The NRC's Office of Research is studying new methods of evaluating operating experience. They include probabilistic analysis of component reliability and extensions of fault-tree analysis to identify key safety components in reactor systems. Several analytical tools already available to the NRC might also be readily adapted to regulatory decisionmaking. The models for statistical analysis of LERs presented in the ACRS report (108) and the Licensee Performance Model conducted by Tecnekron Inc. under NRC contract (109) are both examples of possible evaluation models that could be formally integrated into regulatory decisionmaking.

Once the analytical procedures have been agreed on, it is possible that additional data from before the accident will have to be obtained to meet the new data needs.

One means of improving data acquisition would be to increase the diversity of data sources by requiring vendors and designers to report more extensively on events at operating reactors. Vendors are in a good position to identify generic problems with power plants of their own design. They have the greatest knowledge of the technical assumptions and analytical methods employed in the designs of their components and reactor systems. It is appropriate that they identify and report to the NRC on inconsistencies between operations and state-of-the-art approximations used in modeling and design.

NRC RESPONSE TO IDENTIFIED PROBLEMS

When a problem is identified through evaluation of operating experience, the NRC can respond in two primary ways. It may disseminate the information industry-wide or to a select group of utilities or it may promulgate new regulations for implementation by industry.

DISSEMINATION

The Senate TMI investigation report concluded that NRC's past methods of disseminating operations information have been generally weak and unsystematic. For example, the NRC's failure to convey the significance of the Davis Besse accident on September 24, 1977, to licensees permitted an important precursor to the TMI accident to go unheeded. (110)

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[27] See p. 311.

The principal vehicles for dissemination of operating experience prior to and since TMI, by program office, are:

Office of Management and Program Analysis.—LER Abstracts to LPDR (Local Public Document Room, 1717 H Street, N.W., Washington, D.C.). Monthly LER Summaries, Special Data Searches by request, Power Reactor Events, Abnormal Occurrence Reports, Bulletin Information Report.

Office of Nuclear Reactor Regulation.—Generic Letters, Technical Reports.

Office of Inspection and Enforcement.—Bulletins, Circulars, Information Notices. (111)

Based on available information, it appears that since the TMI accident little has been done to improve on the methods of information dissemination in the NRC. On April 15, 1980, the NRR did issue a new requirement instructing licensees to communicate reportable operating events among themselves (before this requirement was issued, licensees were only required to communicate events to the NRC.)[28] As of June 1980, the NRC was still waiting for licensees to submit proposals for their information dissemination program.

Another new dissemination method—this one called for by Congress—is also in the planning stages. The 1981 appropriations bill for the NRC includes a proposed requirement that AEOD issue semi-annual reports of data and findings to the NRC Commissioners, who are then to transmit them directly to Congress.

REGULATORY RESPONSES

At present, the senior members in the Office of Nuclear Reactor Regulation—with input from analysis groups throughout NRC—decide what to communicate to licensees, including proposed changes in licensing requirements at operating plants. According to a recent proposed reorganization of the Office, final approval must come from either the Director of the Division of Safety Technology (DST, previously Division of Systems Safety), or the Director of the Division of Project Management (DPM). (112) Cases involving major safety concerns might demand attention by the Director of the Office of Nuclear Reactor Regulation or by the Commissioners.

The preliminary interface agreement that is pending between the Office of Nuclear Reactor Regulation and AEOD states that:

> NRR will feed back the experience gained through the process of analysis of specific operational events into the NRC licensing process, as appropriate, and will provide feedback to licensees, to applicants for construction permits and operating licenses, and to the ACRS and other organizations, as appropriate. AEOD will feed back the results of its operational experience analyses to NRC and other non-licensee organizations, and will request that NRR forward information to reactor licensees and construction permit holders that OAEOD believes to be particularly significant.
>
> NRR will implement follow-on measures (i.e., corrective action) recommended as an outgrowth of operational data analysis within NRR or AEOD with a priority consistent with its importance in relation to other issues under the purview of NRR. (114)

Eisenhut discussed the responsibilities of his office, NRR:

> . . . I&E cannot generate new requirements. Only NRR can generate new requirements . . . There are only two places in NRR that could issue new requirements to plants . . . The ultimate stop is me. (115)

With respect to the role of the AEOD, Eisenhut said:

> Carl Michelson's role is much more the way it was developed and laid out, he looks more at trends. He does not get involved in a particular operational event per se. He gets involved to see what he learns from it, but he does not get involved to see, should he be doing something about it. (116)

Eisenhut elaborated further:

> . . . Michelson's group will send recommendations. His group does not have licensing authority to generate requirements. He can say and do everything he wants to say and do but it is not a licensing requirement until it goes out to licensees. (117)

Thus, while AEOD does provide input, it does not have any final decisionmaking authority growing out of operations evaluation.

The most powerful lever AEOD has for seeing that the NRC responds to lessons learned from analysis of operating experience is to send recommendations to the Executive Director's Office. However, other program offices may do likewise. An important question is how much weight will be given to an AEOD recommendation for regulatory change when it is at odds with any NRR recommendation.

It is premature to judge during this initial phase of program development whether either analysis and evaluation or implementation of these activities will be effective. However, the lack of emphasis to date on operations evaluation leading to regulatory change, based on lessons learned from operating experience, suggests a continuation of the business-as-usual attitude that existed prior to the Three Mile Island accident.

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[28] The accident at Crystal River, which occurred March 1980, might have been avoided if the new inter-licensee dissemination program had previously been in effect. The problem at Crystal River had been identified and solved at another nuclear power facility two years earlier, but the utility never disseminated their experience to other licensees due to a lack of a suitable vehicle. (113)

POTENTIAL IMPACT OF THE OPERATIONS EVALUATION PROGRAM

It will be some time before the effectiveness of the new NRC operations evaluation program can be evaluated. A key question is whether it will be able to contribute to preventing accidents like TMI in the future. Thus far, the NRC does not appear to be using the TMI accident and its associated precursors as a benchmark against which to evaluate the program.

Special Investigation staff posed the following question to the directors of the new operations evaluation units: If the new operations evaluation program had been in place prior to Three Mile Island, would it have identified relevant precursors and prevented the TMI accident?

Berlinger spoke positively about the OEEB program. He said people are now admitting the possibility of serious accidents and are trying to identify precursors to prevent other Three Mile Islands. (118) He noted the absence of a systematic program and of specialized staff in the past (119) and concluded:

> . . . By having a dedicated staff and an organizer for a coordinated program, you reduce the possibility, you don't eliminate the possibilities that precursor events will go unnoticed, [but] you reduce that possibility. (120)

Jordan of OEAB in the Office of Inspection and Enforcement was also encouraging, but more cautious. He said that his office was focusing on safety problems and timely responses and that the chances of their "falling through the cracks" was less. However, "I think it would be foolish for one to guarantee." (121)

Michelson of AEOD was even more cautious:

> I don't know what I can get out of operating data other than an indication that there is a precursor of serious misunderstandings as to how things behave. (122)

He noted that there is no assurance the industry will understand identified problems or that all problems will be uncovered by the program. (123) In particular, he commented that a lot of data would have to be collected in order for some difficulties at plants to be uncovered and that it is important to talk to operators as well as to read the LERs:

> You have got to put quite a picture together. You don't get that out of reading LERs. You would have to get that by going and talking to operators and asking them, "What do you do in this and that kind of case? How do you perceive what you would do?" (124)

Michelson concluded:

> So I am really not a strong believer that I can get out of operating data the precursor that indicates serious misunderstandings. I think [what] I can get out of operating precursors [is information on] equipment problems. I think I can foresee operator response problems related to poor design of equipment, poor location of indicators relative to hand switches, things of this sort. (125)

RECOMMENDATIONS

PROGRAM EVALUATION

One of the most important activities an operations evaluation program should undertake is to devise methods of continuously evaluating its own performance. An oversight group such as AEOD is necessary to the success of the operations evaluation program.

Goals and criteria for the oversight task should be further elaborated and procedures should be written. Specific responsibility for the task should be assigned to a qualified group.

PROGRAM ORGANIZATION

The organization of the operations evaluation program should be reconsidered by the Commission. The existing organization or any new organization, and its effect on program performance, should be subject to continuous oversight and review. A qualified management oversight group should be assigned to monitor the program.

DATA ACQUISITION

Because of the limitations imposed on operations evaluation by the quality of current data sources, the NRC operations evaluation groups should devote a sizable percentage of their manpower and resources to improving the data base and data acquisition. Criteria and specifications should be developed and documented to describe the content, format and application of operations data. The NRC should make clear to the public and the nuclear industry precisely what operations data the NRC is seeking and how it plans to use them.

The NRC should initiate new programs to explore innovative methods for acquiring and managing the data, such as the incentive program being considered by the Office of Nuclear Reactor Regulation. The NRC should study methods employed by other regulatory agencies such as the Federal Aviation Administration. The Office of Research might conduct studies or let contracts to private industry or the National Laboratories to examine data acquisition methods. General procedures should be developed to guide studies on data acquisition methods, with the ultimate objective of formally adopting and implementing proven methods.

The NRC should expand its regulatory oversight over the vendors and suppliers of reactor components and over the architect-engineering firms that design and build nuclear power plants. Through regulation, vendors should be drawn into the operations evaluation and reporting process beyond what is now called for in 10 CFR 21.

Reactor-vendors—particularly the major nuclear steam system suppliers (NSSS)—should be subject to reporting and analyzing events, as are licensees. They should be responsible for incorporating their expertise on the design of their components and systems into the analysis and interpretation of licensee events at nuclear power reactors.

Vendor reporting requirements should be based on more specific reporting criteria, to be developed by the NRC. The NRC should prepare evaluation procedures for vendors to follow, rather than directing each vendor to develop its own. Technical specifications similar to the licensees' Technical Specifications should be developed to guide vendors in analyzing and reporting on operating problems.

The NRC should further refine the regulations in 10 CFR 21 to establish what constitutes knowledge by a vendor of a design problem. The NRC should firmly establish the line between an open technical question that is being studied by a vendor and a verified problem. Limits should be placed on the time vendors have to respond to technical questions posed by regulatory authorities.

DATA ANALYSIS

Research in plant operations evaluation methods should be continued and expanded within the Office of Research as a means of producing analytical instruments to be formally incorporated into the regulatory process. Further, intra-agency research in management decisions should be coordinated between the Office of Research and the Office of Nuclear Reactor Regulation to develop standards for decisionmaking and for methods and procedures for resolving safety issues. Developments in "systematic regulatory decisionmaking" should be pursued and implemented expeditiously when found as a necessary complement to the NRC's recent efforts at "systematic evaluation" of nuclear reactor operations.

REGULATORY DECISIONS

The NRC should establish criteria, objectives and auditable procedures for reaching regulatory decisions on known safety issues. It should define the relationships between economics, cost, risks and safety as they apply to such regulatory decisions. The NRC should develop a means of presenting all safety issues in an easily recognizable format so that their relative significance can be observed and easily understood. Ideally, the NRC and the industry must work together toward the establishment of a safety goal that would set forth quantitatively the acceptable levels of risk and safety in nuclear power, to be used as a benchmark for regulatory decisions.

One means of providing a more systematic approach to incorporating lessons learned from operations evaluation into licensing and regulation would be for the agency to adopt certain methods of operations analysis as decision instruments. Conceivably, benchmarks in analytical results would be established by regulation, providing a base against which to compare the results of analysis of specific cases.

The idea of incorporating analytical specifications into the regulations is not new to the NRC. For example, Appendix K to Part 50 of the 10 CFR specifies in detail the technical models and criteria that can be used in the design and evaluation of reactor Emergency Core Cooling Systems (ECCS).

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Part II

The Nuclear Power Industry

Chapter 1

A Review of the Nuclear Safety Analysis Center and the Institute of Nuclear Power Operations

By

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INTRODUCTION

The Special Investigation of the Subcommittee on Nuclear Regulation into the accident at Three Mile Island identified a need for improvements in a range of areas in both the NRC and the nuclear industry. (1) This study reviews some of the principal elements in the response of the commercial nuclear power industry to the accident at Three Mile Island some 15 months later.[1] Included are descriptions of the programs and progress made by the newly-formed Institute of Nuclear Power Operations (INPO) and the Nuclear Safety Analysis Center (NSAC). In addition to identifying the positive progress made by these organizations, constructive criticism is offered in some areas, and some of the outstanding questions and issues are discussed.

The study was intentionally confined to the activities of INPO and NSAC. A thorough analytical treatment of the response of the entire industry would have required more time and resources than were available. However, in order to provide a context for the work and progress of INPO and NSAC, an overview of some other industry programs is provided.

The study is based on interviews conducted by Special Investigation staff. Interviewees included officials from INPO, NSAC, the Electric Power Research Institute (EPRI),[2] the TMI Ad Hoc Nuclear Oversight Committee,[3] the Atomic Industrial Forum Regulatory Committee,[4] and the NRC. Additional source material included documents of INPO and NSAC and other written material in the public record. In an effort to gather a spectrum of views and to identify the potential issues surrounding the viability of INPO and NSAC, outspoken individuals with extensive experience in nuclear power were contacted. (3)

The programs discussed in this report are at varying stages of development. Many of INPO's activities, for example, are just now getting underway, and INPO staffing has been slower than anticipated. Consequently, it is premature to form judgments about these programs. In instances where programs are further along or where documentation is available, an attempt was made to make more specific comments.

It is hoped that the report will be of use to the Subcommittee and to INPO and NSAC in their own critical appraisals and continuing upgrading and improvement of programs.

THE NEED FOR INDUSTRY ACTION

Following the accident at TMI, many independent and parallel investigations and studies were conducted. Included are those of the Senate Special Investigation (4), The President's Commission on the Accident at Three Mile Island (5) and the Nuclear Regulatory Commission Special Inquiry Group. (6) Each made recommendations directed toward both the industry and the NRC. In this section, the findings and recommendations relating to the industry are reviewed in order to provide a framework for assessing the industry's response. It should be noted that the NRC's response to the accident has encompassed virtually all of the recommendations of the various investigations and entails several activities that overlap with industry initiatives. (7)

While both the NRC and the industry have undertaken major initiatives since the accident, there remain several unresolved issues. For example, both the NRC and the industry are trying to define an overall safety objective [5] that would help to rationalize the management of their organizations and to form the basis for evaluating the adequacy of the post-TMI initiatives. Such unresolved issues should be recognized when making judgments about the adequacy of the various industry programs.

REACTOR SAFETY NEEDS

The industry-related findings and recommendations of three of the major investigations are reviewed below. Taken together, the results of these independent studies show some areas of common concern, some findings unique to each investigation, but no examples of contradictory findings or recommendations.

SPECIAL SENATE INVESTIGATION

The Special Investigation of the Subcommittee on Nuclear Regulation did not forward specific recommendations, but did reach conclusions that suggest the need for improvements in selected areas of commercial nuclear power safety. Three broad areas were identified, encompassing several sub-issues. These areas call for improvements in improving the human element in reactor safety,[6] improved use of operating experience and improved emergency response to nuclear accidents.

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[1] More details of the intended purpose and scope of the investigation and study are described in a report to the Senate. (2)

[2] EPRI is a research institute supported by the electric utility industry.

[3] See p. 336.

[4] See p. 336, fn. 17.

[5] See pp. 334–335. A safety objective or safety goal for nuclear plants would set a target for how safe reactors need to be.

The Human Element in Reactor Safety

The Special Investigation found, as did the other investigations, that insufficient attention had been paid to the human element in nuclear power plant operations. Deficiencies were identified in the areas of operator training, control room design and emergency procedures.

The findings and conclusions contained in the Special Investigation report state that

> There were several weaknesses in the TMI operator training program . . . These weaknesses included:
>
> - Limited training in multiple-failure accidents, particularly such prolonged ones as experienced on March 28 at TMI.
> - Limited training in the basics of nuclear power plant physics and behavior. (8)

With regard to the control room, the Special Investigation found several design weaknesses, including:

> - A system of some 1,200 alarms, of which several hundred went off in the first minutes . . . the alarms would provide little, if any, immediate assistance in diagnosing a major transient or in assigning priorities to accident conditions. . . .
> - A computer system that was . . . of little help. . . .
> - Indicators of conditions in the reactor coolant drain tank (pointing to a LOCA) that were not directly visible to plant operators. . . .
> - The lack of instrumentation to measure water level in the reactor vessel directly.
> - Instrumentation that was designed only for normal operating conditions and could not provide readings for the extreme conditions produced by the accident. (9)

Finally there were human element deficiencies in the area of emergency procedures:

> The emergency procedures for Unit 2 were vague, confusing, incomplete and not fully understood by plant personnel. They did not provide useful guidance to operators and managers in identifying and responding to the critical elements of the accident in the early hours. (10)

Operating Experience

The Special Investigation, as did the other investigations, found that

> The deficiencies in industry and NRC programs for evaluating and acting on operating experience at nuclear powerplants were among the most important inadequacies in the nuclear safety program brought to light by the accident. (11)

Emergency Planning and Response

A variety of observations were made relating to the emergency preparedness of the utility. These observations must generally be placed in the context of NRC and State performance, as well.

The Special Investigation concluded that

> . . . the utility, the NRC and the State did not readily have available the resources essential for a proper response . . . a fundamental reason for their lack of preparedness was conceptual: unduly narrow assumptions had been made as to the kinds of accidents to be anticipated. (12)

Further,

> The utility's response was inadequate, particularly with respect to management and communications. Statements by members of the utility's emergency command team indicate that many decisions during the first day were based upon incomplete information because they [the members] failed to share what they knew or believed about plant conditions. (13)
>
> There was a lack of coordination among the utility, the NRC and the State in their emergency planning. (14)
>
> The utility's outside communications were poor, leading Congressman Morris K. Udall to raise questions as to "Why on March 28 . . . [government] officials and the public were denied important information" about plant conditions. (15)

Finally,

> The utility was remiss in not clearly communicating its uncertainty [regarding the condition of the reactor] on the morning of the first day to the NRC and the State. (16)

THE PRESIDENT'S COMMISSION INVESTIGATION

For purposes of comparison, the recommendations of the President's Commission can be grouped in a fashion similar to that provided above for the Senate Special Investigation.

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[6] The human element as used here refers to all operator-related aspects of plant design and operation, including human factors. The term "human factors" refers to the physical and psychological needs, capabilities and limitations of people. Consideration of the human element might include such things as operator pay scales and training in the fundamentals of plant behavior, while human factors would not.

With regard to the industry's efforts in operator training,

> It is important to attract highly qualified candidates for the positions of senior operator and operator supervisor. Pay scales should be high enough to attract such candidates. (17)
>
> Individual utilities should be responsible for training operators who are graduates of accredited institutions in the specifics of operating a particular plant. These operators should be examined and licensed by the restructured NRC, both at their initial licensing and at the relicensing stage. In order to be licensed, operators must pass every portion of the examination. Supervisors of operators, at a minimum, should have the same training as operators.
>
> Training should not end when operators are given their licenses.
>
> Comprehensive ongoing training must be given on a regular basis to maintain operators' level of knowledge.
>
> Such training must be continuously integrated with operating experience.
>
> Emphasis must be placed on diagnosing and controlling complex transients and on the fundamental understanding of reactor safety.
>
> Each utility should have ready access to a control room simulator. Operators and supervisors should be required to train regularly on the simulator. The holding of operator licenses should be contingent on performance on the simulator.
>
> Research and development should be carried out on improving simulation and simulation systems: a) to establish and sustain a higher level of realism in the training of operators, including dealing with transients; and b) to improve the diagnostics and general knowledge of nuclear power plant systems. (18)

The need for improved control room design was described in technical terms:

> Monitoring instruments and recording equipment should be provided to record continuously all critical plant measurements and conditions. (19)
>
> Equipment should be reviewed from the point of view of providing information to operators to help them prevent accidents and to cope with accidents when they occur. Included might be instruments that can provide proper warning and diagnostic information; for example, the measurement of the full range of temperatures within the reactor vessel under normal and abnormal conditions, and indication of the actual position of valves. Computer technology should be used for the clear display for operators and shift supervisors of key measurements relevant to accident conditions, together with diagnostic warnings of conditions.
>
> In the interim, consideration should be given to requiring, at TMI and similar plants, the grouping of these key measurements, including distinct warning signals on a single panel available to a specified operator and the providing of a duplicate panel of these key measurements and warnings in the shift supervisor's office. (20)

With regard to emergency procedures, the President's Commission recommended that the licensee assume responsibility:

> Since, under our recommendations, accountability for operations during an emergency would rest on the licensee, the licensee must prepare clear procedures defining management roles and responsibilities in the event of a crisis. (21)

It went on to recommend

> Substantially more attention and care must be devoted to the writing, reviewing, and monitoring of plant procedures.
>
> The wording of procedures must be clear and concise.
>
> The content of procedures must reflect both engineering thinking and operating practicalities.
>
> The format of procedures, particularly those that deal with abnormal conditions and emergencies, must be especially clear, including clear diagnostic instructions for identifying the particular abnormal conditions confronting the operators.
>
> Clearly defined roles and responsibilities for operating procedures and practices must be established to ensure accountability and smooth communication. (22)

Operating Experience

The President's Commission concluded that, in the industry,

> There must be a systematic gathering, review, and analysis of operating experience at all nuclear power plants coupled with an industry-wide international communications network to facilitate the speedy flow of this information to affected parties. If such experiences indicate the need for modifications in design or operation, such changes should be implemented according to realistic deadlines. (23)
>
> Management of both utilities and suppliers must insist on the early diagnosis and resolution of safety questions that arise in plant operations. They must also establish deadlines, impose sanctions for the failure to observe such deadlines, and make certain that the results of the diag-

> noses and any proposed procedural changes based on them are disseminated to those who need to know them. (24)

Emergency Planning and Response

The President's Commission recommendations on emergency planning were extensive and are summarized here for the sake of comparison. They are not clearly directed toward industry, but in the cases cited below would probably involve some industry initiative if adopted.

> Emergency plans must detail clearly and consistently the actions public officials and utilities should take in the event of off-site radiation doses resulting from release of radioactivity. . . .
>
> Plans for protecting the public in the event of off-site radiation releases should be based on technical assessment of various classes of accidents that can take place at a given plant. . . .
>
> Research should be expanded on medical means of protecting the public against various levels and types of radiation. . . .
>
> If emergency planning and response to a radiation-related emergency is to be effective, the public must be better informed about nuclear power. The Commission recommends a program to educate the public on how nuclear power plants operate, on radiation and its health effects, and on protective actions against radiation. . . .
>
> Commission studies suggest that decisionmakers may have over estimated the human costs, in injury and loss of life, in many mass evacuation situations. The Commission recommends study into the human costs of radiation-related mass evacuation and the extent, if any, to which the risks in radiation-related evacuations differ from other types of evacuations. . . . (25)

Other Recommendations to Industry

The President's Commission also made two broad recommendations directed toward industry. First, it should set and police its own standards:

> To the extent that the industrial institutions we have examined are representative of the nuclear industry, the nuclear industry must dramatically change its attitudes toward safety and regulations. The Commission has recommended that the new regulatory agency prescribe strict standards. At the same time, the Commission recognizes that merely meeting the requirements of a government regulation does not guarantee safety. Therefore, the industry must also set and police its own standards of excellence to ensure the effective management and safe operation of nuclear power plants.
>
> The industry should establish a program that specifies appropriate safety standards including those for management, quality assurance, and operating procedures and practices, and that conducts independent evaluations. The recently created Institute of Nuclear Power Operations, or some similar organization, may be an appropriate vehicle for establishing and implementing this program. (26)

Second, the management within each utility should meet uniform standards of quality:

> Integration of management responsibility at all levels must be achieved consistently throughout this industry. Although there may not be a single optimal management structure for nuclear power plant operation, there must be a single accountable organization with the requisite expertise to take responsibility for the integrated management of the design, construction, operation, and emergency response functions, and the organizational entities that carry them out. Without such demonstrated competence, a power plant operating company should not qualify to receive an operating license. (27)

Further,

> Although the Commission considers the responsibility for safety to be with the total organization of the plant, we recommend that each nuclear power plant company have a separate safety group that reports to high-level management. Its assignment would be to evaluate regularly procedures and general plant operations from a safety perspective; to assess quality assurance programs; and to develop continuing safety programs. (28)

THE NRC SPECIAL INQUIRY GROUP INVESTIGATION

The stated objective of the Special Inquiry Group was not

> to duplicate the efforts of the President's Commission on the Accident at Three Mile Island . . . [but to] enable the NRC to fulfill its regulatory responsibilities by achieving the fullest possible understanding of the accident, both from a technical point of view and from the standpoint of how the NRC's own regulatory processes functioned. (29)

The findings and recommendations put forward by the Special Inquiry Group complement those of the Senate Special Investigation and the President's Commission and stress the NRC more than the industry.

The Human Element in Reactor Safety

Regarding the deficiencies in operator training identified by the accident,

> There is a clear need to restructure and improve operator training, and to upgrade substantially the requirements for technical qualifications of onsite super-

> visors and management up through the plant or unit superintendent. (30)
>
> The inadequate training that played a role in this accident must be attributed not to one utility but rather to the industry as a whole and to the NRC. (31)
>
> After the accident one Met Ed official, in coordination with B&W, initiated a simulator training program that illustrates the direction we think operator training should take. First, the simulator was programmed not to deal just with startups or "routine" transients but with various accident sequences. Then, instead of a crew of Met Ed operators splitting up so that some studied books while others worked on the simulator, the entire crew was taken through a number of accident sequences and graded on their responses *as a team*, not as individuals. Some of these accident sequences were not limited to a single failure, but were multiple failure accidents. And they were not, as is customary, "short" accidents. The simulator was programmed to play accidents out over a long period of time. The goal was not to "beat the game" but to limit the damage—failure after failure was "sent in" by the programmers to see how well the operators would diagnose the casualties and react to them. (32)

The Special Inquiry Group went on to say, however,

> In our view, improved training programs for control room operators and senior operators will not be sufficiently upgraded by the nuclear industry unless the NRC drastically modifies its own attitude toward this training. We recommend that the NRC assume a direct role in the training of operators, much as the FAA does in the training of pilots: certification of training facilities; establishment of a minimum curriculum; and certification of instructors. The NRC should promulgate criteria for these facilities and instructors, and review and approve the curriculum for the initial and recurring training programs. It should retain its present authority to test and license operators and supervisory operators. (33)

The Special Inquiry Group concluded that the display of information in the control room at TMI was inadequate and outdated:

> . . . the information . . . about plant status and important plant parameters was far below . . . an acceptable minimum for such a sophisticated technology demanding quick action in the case of potential accidents. (34)

The Special Inquiry Group doubted that the industry would take prompt action in applying human factors engineering principles to control room design. It recommended NRC initiative in this area:

> We think that in addition to specifying what parameters must be monitored with the on-line reactimeter, the NRC should move promptly to establish other requirements for parameters that must be displayed in the control room and their required ranges. Moreover, using human factors engineering, the NRC should move forward to develop criteria for control room design such as functional grouping of instruments and controls, panel layout, and alarm systems that will define the overall outline of a standardized control room design. Experience has shown that the industry will likely be slow to move on this front unless the regulatory agency itself lays out minimum requirements and a deadline for implemention of these requirements. (35)

As did the Special Investigation and the President's Commission, the Special Inquiry Group also concluded that full-range diagnostic equipment was needed to monitor accident parameters:

> A significant problem during the Three Mile Island accident was that much of the instrumentation was designed for normal, not accident, conditions. When things began to go wrong, instruments quickly went off scale. This was particularly true for many radiation-monitoring instruments. The ACRS has been conducting a running, but unsuccessful, battle with the NRC staff for some time to require every plant to install instrumentation sufficient to monitor the course of an accident. Only after the accident occurred—more than 3 years from the time a new regulatory guide providing for such instrumentation was first proposed by the staff in December 1975—has the NRC decided to expedite implementation of such a requirement. (36)

With regard to emergency procedures, the Special Inquiry Group focused only on the needs within the NRC and not on the utility's operating procedures.

Operating Experience

Again, the Special Inquiry Group paralleled the other two investigations in strongly recommending improved, systematic evaluation of operating experience:

> . . . the structure of the nuclear industry has not been conducive to the effective sharing and integration of operating data. The utilities that operate the plants have never mobilized an industry-wide effort to concentrate on safety-related operational problems. As for the four principal U.S. manufacturers of reactors ("vendors")—General Electric, Westinghouse, Combustion Engineering, and B&W—we found a great deal of

> variation in the extent to which they monitor at their own expense operating problems in the plants they have built, after those plants are tested and turned over to the utilities that have purchased them. And the relationship between the vendor and its utility customer after operation of a plant begins is largely determined by the individual utility's choice of how much technical assistance it is willing to buy from the vendor on an ongoing, contract basis. Moreover, there is no requirement that utilities report failure data to the vendors. (37)
>
> We have concluded that the systematic evaluation of operating experience must be undertaken on an industrywide basis, both by the utility industry, which has the greatest direct stake in safe operations, and by the NRC. The utility industry has already put in motion plans to establish an Institute [of] Nuclear Power Operations (INPO), funded by all the nuclear utilities, that will undertake this task. Whether it will be successful remains to be seen. We are less sanguine about the steps the NRC has taken to date to deal with this problem. (38)

Emergency Planning and Response

The industry's role in this activity was not stressed by the Special Inquiry Group, but one recommendation called for an industry-run offsite data center:

> The technology exists today for remotely displaying essential information and for providing direct, continuous oral communications. We recommend that one or more "data centers" be established to which essential plant parameters would be telemetered automatically from the display computer systems of every nuclear plant. At least one of these centers would be staffed by experts in reactor operations and reactor engineering with detailed knowledge of the various plant designs. Simulators, computers for diagnostic assistance, and other special capabilities could be made available from these data centers. (39)

Other Recommendations to Industry

The Special Inquiry Group suggested three other fundamental areas of need for industry action: a new "shift technical advisor" for each operating reactor, improved radiation protection programs and formation of a new industrywide consortium.

Regarding the shift technical advisor:

> . . . what we are proposing is a substantially more detailed, upgraded set of requirements for technically competent supervisory and management officials certified by the NRC to be present on each shift to direct the operation of the plant. This will require not just that additional criteria be drafted, but also that new methods of certification be developed to ensure the management and technical qualifications of utility personnel. And in order for the NRC to certify the technical competence of onsite supervisory personnel, it will have to upgrade the competence of its own staff in the process. (40)

Several mishaps during and after the accident at TMI pointed to the need for improving health physics practices:

> The accident has shown that radiation protection, which has always been considered a "necessary evil" and secondary in importance to reactor operations and reactor safety, must be given a high priority. At reactor sites, the radiation protection function should be made independent of operations and be elevated to equal importance. And the NRC should give greater emphasis in both its safety review and inspections to radiation protection. To do so, the NRC will have to acquire more expertise in this area. (41)

Finally, the Special Inquiry Group suggested that some of the weaker utilities might experience difficulty in responding to the identified reactor safety-related needs that stemmed from the accident. It noted that NRC and industry initiatives had been numerous and that the utilities had to draw from limited manpower and financial resources. Consequently, it recommended:

> . . . that a number of existing plants now owned by different utilities could be operated (and new plants constructed) by an industrywide consortium or a public corporation such as COMSAT. This entity would manage the plants, select, train, and employ operators, supervisors, and engineers, standardize operating conditions and procedures, and, with the cooperation of vendors, systematically evaluate operating experience and implement changes in design or operations. Operating budgets could then be developed on a systemwide basis. (42)

WHITE HOUSE STATEMENT ON THE PRESIDENT'S COMMISSION REPORT

The Office of the President reviewed the findings of the Commission and made proposals to the utility and its suppliers. The statement made direct reference to the INPO and NSAC organizations:

> Safety of nuclear reactors can be significantly improved through a pervasive and knowledgeable involvement by utility top management in seeking safe and reliable plant operation. Indeed, the primary reform must come from within the utility industry and its suppliers. Industry initiatives since the accident to improve

safety, such as the establishment of the Institute of Nuclear Power Operations (INPO) and the Nuclear Safety Analysis Center (NSAC) should be pursued and augmented. An industry-sponsored central technical organization should address the deficiencies revealed by the accident at Three Mile Island. In addition, the NRC is establishing upgraded requirements for management competence, operating procedures, independent review and system safety evaluation. These steps represent important initiatives, but they are only a start. The President, therefore, calls for the following actions:

- The management of nuclear utilities must follow through on the safety improvement programs that have been announced, add to and strengthen these programs, and demonstrate a commitment to safety that goes beyond mere compliance with regulation.
- A concept of personal responsibility must be applied: a competent and well trained decisionmaker must always be in charge at the corporate level and at the plant site. Primary responsibility for safety must rest with the utility companies that operate and maintain nuclear powerplants.
- INPO and NSAC are asked periodically to inform the Chairman of the NRC and the Oversight Committee of their objectives, milestones for implementation, progress in meeting these milestones, and the results of their independent evaluation of utility performance.
- NSAC should direct early attention to evaluating the readiness and assisting in the safety upgrading of those utilities with nuclear generating stations under construction which would have a major impact on the displacement of foreign oil. NRC is encouraged to do likewise, making use of the NSAC efforts as appropriate.
- The Oversight Committee is directed to monitor industry progress, identify opportunities for accelerating and strengthening the improvements which have been initiated, and identify potential opportunities for Federal assistance in these efforts.
- The Secretary of Energy is directed to provide appropriate assistance to the industry and the Oversight Committee. NRC is required to evaluate and accredit industry efforts to assure that prompt and effective attention is being given to needed safety reforms. (43)

For ease of comparison, the President's recommendations have also been broken out as they were for the other investigations.

The Human Element in Reactor Safety

With respect to operator training:

> The President is particularly concerned with the Commission's findings that neither the industry nor the NRC gave adequate attention to the competence of operator and supervisory personnel. Instead, the safety of commercial nuclear power was equated with engineered equipment to the neglect of the human element.
>
> Of special concern is the lack of attention and devotion of resources to the training of operators which the Kemeny [President's Commission] investigation revealed. It is clear that site managers must consider themselves responsible for operator training. The training organization in each utility must be staffed by motivated, educationally qualified instructors. There must be training for engineers and managers at a level higher than control room operators. Throughout all this training, the basic principles of science and engineering which govern nuclear plant safety and reliability must be emphasized. Finally, a rigorous requalification program is absolutely necessary to assure that plant operations are improved and skills once developed are not lost.
>
> The President strongly supports the Commission recommendations for improved training of operator and supervisory personnel. In response to the TMI accident, the NRC is revising its requirements with respect to operator training and qualifications. INPO will also be directing its early attention to this area. Because of the importance of meaningful and timely improvement in knowledge and capabilities of personnel involved in nuclear plant management, operation, and maintenance, the President is:
>
> - Requesting that NRC inform the Oversight Committee within four months on its progress in implementing the Commission recommendations for a) more rigorous criteria for operator and supervisor qualifications, b) expanded and improved use of simulators in training, c) NRC examination and recertification of licensed operators, and d) criteria for accreditation of training institutions.
> - Asking INPO, with assistance as needed from DOE, to make an assessment of the total manpower and training requirements of nuclear

utilities and to develop a program for upgrading and accrediting training institutions.

- Urging utilities to work together to review and improve their international training programs in accordance with the criteria discussed above.
- Directing Federal agencies which have significant experience in the training of technical personnel analogous to nuclear utility operations, such as DOD, NASA, FAA and DOE, to cooperate with NRC and INPO in identifying areas where assistance might be provided.
- Directing the Oversight Committee to review utility training programs, drawing on DOE assistance as appropriate, to evaluate NRC's progress on upgrading regulatory requirements, and to report to the President within six months. (44)

In the area of improved control room design, the President supported the President's Commission recommendations and noted that

> . . . NRC and its licensees are beginning to apply many of the technical lessons learned from TMI. As the industry and the NRC carry out their programs of technology improvement, the President has urged that special emphasis be placed in the following areas:
>
> - Plant designs, equipment, control rooms, training, etc., should be standardized insofar as practicable.
> - Control rooms should be simplified in display and control. (45)

UNRESOLVED ISSUES

Clearly, many highly specific needs have been identified by the many investigations of TMI, and action has been taken both by the NRC (46) and by the industry.[7] The Office of the President has issued several directives to the industry and to Federal agencies pursuant to his Commission's recommendations.

Nevertheless fundamental questions remain. They pertain to the manner in which the NRC and the industry make decisions on needed safety improvements, along with the formal approach that is used by either party to manage its own safety programs. In the first instance, articulation of a safety goal could provide a criterion for decision-making, but it is difficult to formulate a goal that would be accepted by a wide range of people (NRC, public, industry, etc.). In the second instance, while both the NRC and the industry say they share a common objective—improved plant safety, the approaches developed by each to implement that objective are quite different, leaving open the question of how improved safety may best be achieved. The background for each of these issues is provided below in order to help place the present activities of the NRC and the industry in context.

SAFETY GOALS [8]

Following the accident, the NRC gave thought to how it had regulated the nuclear power industry in the past and whether a modified approach toward implementing safety improvements was needed. In the final report of the TMI–2 Lessons Learned Task Force,[9] the NRC said:

> . . . although the NRC staff deals in concepts of safety and risk every day from a predominantly scientific and analytical perspective, the public, the Congress, and the media generally react to their perception of risk whether or not it comports with the best technical assessments of reality. Lacking a national consensus on the approach to making safety judgements, there is an acute need within NRC for policy guidance to flow from the highest levels of the agency to the technical staff on what is an acceptable safety goal of reactor regulation. (47)

While the Task Force did not feel uniquely capable of proposing the goal, it did describe several possibilities, making clear the need for public policy input into the decision:

> There are a myriad of possible goals . . . the goal could be phenomena oriented such as no core meltdowns; it could be consequence oriented in terms of offsite releases, health effects, or property damage; it could be approached from an optimization point of view in terms of "as safe as reasonably achievable" or best technology available; or it could be based on the comparison of risks with those of other energy technologies. Most, if not all, of the possible formulations of a safety goal could be expressed in qualitative or quantitative terms. (48)

The Congress asked the NRC to spend one year, ending September 1981, formulating a safety goal (49), but its directive to the NRC did not go beyond requiring a study. Adoption of a goal by the NRC and/or review by Congress has not been scheduled.

As discussed later in this report,[10] NSAC officials have proposed a safety goal that is phenomena-oriented (no core damaging accidents within 30 years, etc.). However, industry representatives are not completely settled on this issue. According to the president of EPRI, the idea of a simple goal, expressed in term of probabilities of failures (an approach used in Great Britain), may not be the answer:

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[7] See pp. 335ff.

[8] For further discussion of the NRC's program to develop a safety goal as a guide for backfitting decisions, see Part I, Chapter 2, pp. 39ff.

[9] The NRC formed this Task Force to address questions regarding the agency's fundamental policy in handling broad safety questions. Included in the report is a treatment of nuclear plant operations and design and the regulatory process.

[10] See p. 350.

> . . . the really thoughtful [people] in Great Britain aren't sure that it's a good idea. It provides them with the comfort of having a system, but whether or not it improved the safety isn't for . . . sure. (50)

EPRI's president preferred a more forward-looking approach:

> I think that the goals are best expressed in reasonably clearly defined standards and . . . performance criteria . . . the whole system has to be in a position of precognition—you have to be able to know what's likely to happen downstream, rather than what happened to you a second ago. (51)

Hence, the issue of whether a common safety goal should be adopted by the NRC and the industry remains unresolved. If adopted, and depending on the nature of such a goal, both the NRC and industry safety activities could be affected. Further, the viability of the safety programs of both groups might be viewed in a different light when measured against the new standard.

APPROACH TO SAFETY

Another fundamental unresolved issue pertains to the fact that there is no unique approach to improving reactor safety that is obviously best. In performing its functions, the NRC has tacitly adopted one approach, as embodied in its "Action Plan" and "Operating Plan." (52) The industry has adopted another approach, as exemplified by the formation of INPO, NSAC and other industry entities. In a certain sense, the industry and NRC activities complement one another. In some cases, however, the two groups' competing interests tend to conflict.[11]

In a report to the Special Inquiry Group (53), a consultant suggested yet a different approach toward ensuring nuclear plant safety. The approach draws from experience in analogous industrial activities, was primarily directed toward improving the NRC, but proposed a potential need for the industry to adopt a similar approach. (54) It uses the concept of "hazards analysis," as opposed to risk-based safety.[12] The hazards analysis approach augments the more quantitative risk-based approach by focusing on identification of incipient problems as well as on those that would arise from monitoring equipment failure rates, etc. and compiling statistics. An example of a "hazard" might be poor practices by control room operators.

Hence, the NRC, the industry and the consultants' approaches are all somewhat different, and it is not intuitively obvious which is the best.

INDUSTRY RESPONSE TO THE ACCIDENT

INITIAL RESPONSES

The initial response to the TMI accident by various segments of the nuclear industry was to provide a range of technical assistance to Metropolitan Edison.[13] This effort was initiated by requests for assistance by Met Ed on March 28 and continued for a number of weeks after the accident. (These activities have been adequately described elsewhere and are not discussed here. (55)) Several influential executives from other nuclear utilities were direct participants in the onsite assistance effort at TMI. It was quickly recognized by these executives and by officials from other nuclear industry organizations that the accident had safety implications for other operating nuclear power plants. (56)

Statements by industry leaders indicated recognition that the "lessons of Three Mile Island" must be understood and that, if necessary, changes must be implemented by the nuclear industry. (57) It was realized soon after the accident that high priority should be given to obtaining a detailed understanding of what happened. This information was considered necessary as a basis for detailed reviews of reactor designs and operating practices throughout the industry. (58)

Within a relatively short time after the accident, understanding of the accident developed and was discussed and evaluated by various segments of the industry. Even before detailed technical assessments of the accident were available, various industry groups and individuals had identified areas where improvements either were warranted or should be considered.

A review was conducted of statements made by industry officials before Congress or other public statements during the period April through June 1979. While these statements were generally quite cautious, several themes emerged in regard to areas where improvements might be warranted. The following topics were identified in one or more of the public statements that were reviewed:

- Operator training and operating procedures. (59)

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[11] The debate over whether to design reactors to accommodate accidents more severe than TMI is one case. An example of such hypothesized accidents is a reactor meltdown or a class 9 accident. The NRC's focus on such accidents is rejected by the industry, which maintains that preventing accidents from progressing to the need for core-catchers, etc., is in the common interest. The NRC, however, tends to adopt the idea that measures should be taken to cover the contingency should preventive measures fail.

[12] Risk-based safety is an approach by which the risk to the general public from reactor accidents is calculated. Steps that can be shown to reduce the calculated risk significantly take priority.

[13] The licensed operator and 50-percent owner of TMI.

- Operating utility technical and management capability. (60)
- Operator-equipment interface; communications and information display. (61)
- Emergency planning and emergency response capability, including communications during emergencies. (62)
- Expanded and more systematic safety analysis. (63)
- Plant integration, quality assurance and plant systems reliability.[14] (64)
- Plant systems and equipment design and engineering. (65)

The NRC provided massive stimuli to the industry. Operating utilities and reactor-vendors received a barrage of bulletins, orders and requests for information beginning within several days following the accident. (66) In addition, some State governments launched reviews or investigations to examine the implications of TMI for nuclear power operations in their States. (67)

Individual utilities initiated activities within their own organizations in response to the accident. On the day after the accident, Tennessee Valley Authority (TVA) management, for example, directed the TVA staff to

> . . . follow closely the Nuclear Regulatory Commission's investigation of the . . . accident, to review equipment, design, procedures, and staffing in TVA's nuclear plants, and to report its findings to the board as soon as possible. (68)

In May 1980, the Edison Electric Institute (EEI), a national organization of investor-owned utilities, conducted a survey of individual nuclear utilities, requesting information on their responses to the TMI accident. The preliminary results indicate that perhaps a dozen utilities (out of the 48 who responded) independently had initiated reviews of their own facilities prior to issuance of the NRC Short Term Lessons Learned report (69) in July 1979. (70)

Utility and nuclear industry organizations initiated a number of activities in response to the accident. In April 1979, the EEI established a committee to "coordinate the utility industry response to the Three Mile Island accident." (71) The American Public Power Association (APPA)[15] and the National Rural Electric Cooperative Association (NRECA)[16] were invited to participate on the committee. (72) These two associations agreed, and the TMI Ad Hoc Nuclear Oversight Committee resulted.

According to the committee's chairman, one of the first actions of the Ad Hoc Committee was to ask the Electric Power Research Institute (EPRI) to form a Nuclear Safety Analysis Center. (73) He also said the committee

> . . . provided representatives to testify before numerous congressional committees who have been investigating the TMI accident and considering various legislation. We have provided progress reports to both the NRC, the White House, and the news media. (74)

In April, the Board of Directors of the Edison Electric Institute asked EPRI to perform a technical analysis of the accident and to ". . . identify key reactor safety questions resulting from this analysis." (75) The Nuclear Safety Analysis Center (NSAC) was formed at EPRI to perform this work.

In May 1979, APPA set up a task force to examine issues arising from the accident. (76) The Task Force subsequently made recommendations to the APPA Board of Directors which were adopted by the APPA membership on June 19. 1979. (77) The resolution included:

> 1. The endorsement of the formation of NSAC by EPRI and the recommendation that APPA members contribute funding for NSAC;
> 2. A recommendation for the creation of a "National Academy for Reactor Operators to provide a federally-certified, utility operated and financed center for training of nuclear power plant personnel." (78)

The Atomic Industrial Forum (AIF)[17] also initiated a number of activities. Shortly after the accident, the AIF Board of Directors formed a committee called the AIF Regulatory Policy Committee (79) to

> . . . facilitate the exchange of information among utilities, architect-engineers and constructors, and nuclear steam supply manufacturers, and to provide policy guidance on issues of generic nature arising from the investigation of the accident. (80)

Subcommittees were formed to address each of the following topics: Emergency Response Planning, Operations, Systems and Equipment, Unresolved Generic Safety Issues, Post-Accident Recovery, Safety Analysis Criteria, and Control Room Considerations. (81)

Owners Groups have been formed since the accident to evaluate issues of common concern to utilities that operate reactors of the same manufacture. These groups include, in addition to utility and reactor-vendor representatives, designated contacts within the NRC and NSAC. (82)

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[14] Plant integration refers to the process of ensuring that the various systems and subsystems of a reactor facility, which are often designed, fabricated and installed by different groups, are properly matched in terms of design characteristics and are properly installed.

[15] An association of trade organizations representing more than 1,400 local, publicly-owned electric utilities in 48 States, Puerto Rico, the Virgin Islands, Guam, and the American Samoa.

[16] NRECA is a national service association of 1,000 consumer-owned rural electric systems in 46 States.

[17] AIF is an international association of trade organizations interested in the peaceful use of the atom. Its members include utilities, reactor manufacturers, architect-engineering firms, and reactor component suppliers, in addition to nuclear service firms and other organizations.

Nuclear industry representatives and officials from the Department of Energy (DOE), the NRC and General Public Utilities Corporation[18] met in September 1979 to discuss the acquisition and transfer of information from the TMI–2 facility during cleanup and recovery operations. This resulted in the formation of the TMI Examination Technical Working Group. Its announced purpose was to coordinate and sponsor activities including

> . . . generic R&D [research and development] efforts during the TMI–2 examination that would benefit the design, operation, maintenance, safety, etc., of present and future LWR [light water reactor] plants. (83)

In October 1979, articles of incorporation were filed for a new organization, the Institute of Nuclear Power Operations (INPO). This organization, sponsored by the utility industry, was established to assist utilities in improving the safety of operations at nuclear power plants. The formation of INPO was the result of several months of discussion among various industry organizations, including the AIF Policy Committee (specifically the Operations Subcommittee) and the TMI Ad Hoc Oversight Committee of utility executives. It was based upon the recognition that there was a "vacuum . . . in monitoring and reviewing nuclear operations and training" among the utility industry. (84)

THE NUCLEAR SAFETY ANALYSIS CENTER

NSAC is located in Palo Alto, California at the Electric Power Research Institute. Though housed at EPRI, NSAC is funded separately by the national electric utility organizations outside the EPRI budget. (85) Though facilities and administrative support are provided by EPRI, program management is conducted independently of its Nuclear Power Division.[19] The director of NSAC reports directly to the president of EPRI. (87)

Guidance and oversight are provided by the utility sponsors of NSAC in several ways. The NSAC Subcommittee of the EPRI Research Advisory Committee (a standing committee of utility executives which is part of the EPRI advisory structure) was formed in April 1979 to provide guidance to NSAC. The subcommittee is comprised solely of executives from utilities which operate nuclear power plants. (88) The EPRI board of directors, through the EPRI president, also provides general policy guidance. (89) In addition, the TMI Ad Hoc Committee, which was formed to coordinate all industry activities following the accident, provides guidance to NSAC. (90)

Review and advice to NSAC from outside the industry is provided by a group called the Utility Scientific Advisory Council, comprised of executives, scientists and educators. (91)

For the current fiscal year (1980), NSAC is budgeted at $7.5 million. The funding is provided by the electric utility industry associations[20] through a solicitation of individual member utilities according to funding formulae. The funding formulae are based on the number of nuclear units owned by each member utility. (92) About one-half of NSAC's funds are used to support its staff. The other half supports outside contracts. (93)

Current full-time staff at NSAC are about 50. (94) The original nucleus of NSAC professional technical staff, including technical managers, was largely provided by the EPRI Nuclear Power Division. It was supplemented by a large number of employees loaned to NSAC by various nuclear utilities, reactor-vendors and architect-engineering firms, as well as by consultants. NSAC was formed in April 1979 to perform the detailed analysis of the TMI accident that led to the publication of the first NSAC report in July 1979. (95) Presently, the NSAC professional staff is comprised of about 20 full-time EPRI-NSAC employees with, in addition, about 15 "loan" employees from reactor-vendors and utilities, including several from foreign nuclear power operating organizations. The current strategy is for "loan" employees to spend from six months to two years at NSAC before returning to their organizations. The lending organizations are reimbursed by NSAC. The professional staff members presently at NSAC represent a mixture of technical education backgrounds; all are experienced in various aspects of nuclear research or nuclear power applications. (96)

Examination of various documents relevant to the establishment of NSAC and interviews with NSAC officials revealed that the charter and function of NSAC has evolved during the year since it was formed. As described in early announcements, the organization had the general mission to:

> . . . develop strategies to minimize the possibility of a future accident . . . act as a clearinghouse for technical information on safety issues that emerge following the accident . . . make recommendations for changes in safety systems or operating procedures that would further improve safety. (97)

A specific task was assigned to EPRI and NSAC "to perform a detailed technical analysis of the Three Mile Island accident" and "to identify key reactor safety questions resulting from this analysis." (98)

Present NSAC activities include both open-ended projects involving service and coordination, along with discrete topical studies and analyses. A division of responsibility between NSAC and the EPRI Nuclear Power Division has been delineated for post-TMI work. NSAC is assigned tasks that either require a quick response, using existing tools and knowledge, or that involve rapid communication of safety-related information to utilities (99), whereas the responsibilities of the EPRI Nuclear Power Division have been characterized as long-term research and development (100) or projects requiring methods development, hardware development and testing. (101) Post-TMI responsibilities of the Nuclear Power Division at EPRI include participation in the TMI Technical Examination Group and management of a testing program for power reactor relief and safety valves. The latter program was initiated in response to valve performance issues identified by the NRC in the July 1979 TMI Short Term Lessons Learned report. (102) Industry support of the assessment of health effects in the population surrounding Three Mile Island is also managed within EPRI. (103)

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[18] GPU is the holding company for Metropolitan Edison.

[19] Some post-TMI programs are managed by the Nuclear Power Division, and there is a fair amount of interaction between NSAC and EPRI staffs. (86)

[20] These are the Edison Electric Institute (EEI), the American Public Power Association (APPA) and the National Rural Electric Cooperative Association (NRECA).

The TMI accident has also resulted in some modification in existing research projects managed by the EPRI Nuclear Power Division. These were characterized as changes in emphasis; for example, the accident analysis work has been shifted to emphasize small break loss-of-coolant accidents over large break accidents. In addition, the ongoing work on human factors has been given more emphasis. (104)

Establishment of INPO in September 1979 resulted in the transfer from NSAC of some areas of responsibility. They include those functions and programs which had been classified in NSAC (105) as "plant operations." (106) Several staff members from EPRI and NSAC experienced in plant operations and human factors were transferred to INPO as part of the initial cadre. (107)

Following is a summary of current NSAC programs and activities. It is based on interviews with NSAC officials and an examination of NSAC documents. Below is a list indicating most of the NSAC activities that have been identified:

—Information Clearinghouse for Utilities
—Systematic Operating Experience Evaluation
—Accident Assessment
—Generic Safety Evaluations
—Response to Regulatory Issues.

These include activities conducted directly by NSAC staff, under contract to NSAC and in cooperation with INPO, utilities and other industry organizations.

INFORMATION CLEARINGHOUSE

This activity consists of several parts. Through a contractor, NSAC has established a computer-based communications system using terminals at NSAC and at each nuclear utility. It is operated by a computer firm in Palo Alto. Communications take place via commercial telephone lines. The system, known as NOTEPAD, presents information to the terminals of users. It has a conference-call capability with simultaneous display and communications with a number of terminals. The computer maintains a file of messages for both specific users and the entire community of subscribers. When a user logs in, a list of messages is displayed; the user can call up those directly addressed to him, as well as the general messages to all utilities. (108) The primary purpose of this system is to provide a rapid and efficient means of exchanging information related to safety and plant operations among the utilities, NSAC and other industry organizations. (109)

Plans are under consideration to expand the NOTEPAD conferencing capability to enable its use in emergency situations at power reactors. The objective is to provide an efficient means of transmitting critical information on plant status simultaneously in response to the large number of queries that originate from many sources in such situations. (110)

Following the TMI accident, NSAC established a records management system to handle the large amounts of data and information relevant to the accident. Records (correspondence, reports, data tables, etc.) are microfilmed for convenient storage and retrieval. Each item is abstracted, and key words are established, indexed and entered into the computer data base. The system is intended to provide a central repository for information developed on the accident and on matters relevant to NSAC programs on reactor safety and industry support. The system has features common to typical computerized-literature data base systems with a search and retrieval capability. It also has a capability (limited to two dedicated phone lines) for remote access as well. (111) NSAC periodically publishes an index of documents accumulated in the data base entitled "Indexed Bibliography of TMI-2 Documents in NSAC Working File."

NSAC publishes several additional types of documents for transfer of information to the utilities and to industry groups. For communication of information of such volume that it cannot efficiently be transmitted via NOTEPAD, NSAC uses mass mailings of letter reports to the utilities. Formal topical or technical reports are published by NSAC as studies or evaluations are completed. A newsletter which reports on NSAC and other industry-sponsored safety activities is published by NSAC; it is entitled "*Industry Report.*" (112)

Each utility that supports NSAC financially has an individual staff member designated as the "NSAC coordinator" for the utility. These coordinators meet periodically with NSAC to discuss NSAC projects and to provide information regarding utility problems and needs. Each utility generally has about four individuals, including the designated NSAC coordinator, who have direct access to NOTEPAD. Workshops on NSAC work are also conducted by NSAC as a means of exchanging information with selected groups of technical people from utilities and other industry groups. These have been called, for example, to plan and coordinate projects and to discuss results of NSAC studies and analysis. (113)

OPERATING EXPERIENCE EVALUATION

In conjunction with the utilities and INPO, NSAC operates a program systematically to screen and evaluate information derived from utility operating experience (the so-called Significant Event Evaluation and Information Network, or SEE–IN, program). This effort arose out of a perceived need for a program to identify and warn utilities of trends or events with potential safety implications in order that they can be corrected in timely fashion. There was also a desire to establish a system that would be managed independently of the NRC or the reactor-vendors. (114)

NSAC announced the following objectives for the program in September 1979:

- —Review all available plant event data, including regulatory reports or LERs (Licensee Events Reports), unit outage reporting (NRC Gray Books, NERC, Generating Availability Data System), and equipment reliability data (Nuclear Plant Reliability Data System).
- —Identify possible precursors of more serious events.
- —Alert utilities of significant events that are potentially applicable to their type of plant.
- —Develop information on trends in frequency or intensity to spot possible problem areas or worsening conditions. Promote follow-up action on identified problem areas.
- —Mount a failure analysis effort where needed. (115)

At the time the project was originally formulated, INPO did not exist; the present operation involves the participation of nuclear utilities, NSAC, INPO, reactor-vendors and contractors. (116)

Basic information on operating experience is supplied by the utilities, primarily in the form of Licensee Event Reports (LERs, an NRC-required reporting vehicle) and monthly outage reports. (117) A strategy has been developed to coordinate the flow of information between the participating organizations and to provide appropriate follow-up when warranted. Sequentially, the process is designed to proceed as follows:

> 1) Data Input; 2) Screening; 3) Action Analysis; 4) Detailed Field Investigations; and 5) Results, Dissemination and Follow-up. (118)

Coordination of the data-gathering and screening processes is performed by NSAC; detailed evaluation of the information is performed by NSAC and INPO, in conjunction with originating utilities and supplemented by vendors and contractors as appropriate. Standardized formats for presentation of information and criteria for screening and further analysis have been developed. The screening is performed by experienced engineers who are familiar with the type of plant from which the information is received. When detailed analysis is indicated, the information is routed to the organization with the required expertise. (119)

Events with strong implications for human factors, procedures, training and operations are routed to INPO for evaluation; those involving thermo-hydraulics, neutronics, instrumentation, control and systems are evaluated by NSAC. (120) The NOTEPAD system is used to transmit information on reported events and to coordinate screening and evaluation. (121)

A special task group was assembled to screen the existing backlog of LERs that had previously been filed by utilities (during 1978, 1979 and early 1980) with the NRC. (122) Out of this effort, several areas were identified where additional evaluation was warranted. These were: loss of power on instrument and control buses, overcooling transients, relief and safety valve problems, and failures involving emergency cooling systems. (123)

The NSAC–INPO joint task force that responded to the February 26, 1980 transient at the Crystal River Unit 3 reactor is considered by NSAC officials to represent an example of a detailed field investigation in response to a significant operating event. (124) This is discussed in the following section.

In recognition of the potential value of the experience gained in other industries, NSAC has contracted for a study of programs in the aerospace industry to "learn from experience." A report to NSAC has recently been completed on "Space Programs Failure Reporting Systems." (125)

ACCIDENT ASSESSMENT

The initial NSAC project to analyze the TMI–2 accident was the first example of this type of activity. It has resulted in the publication of a report on the NSAC analysis. (126) Additional work is underway under NSAC management to analyze the technical aspects of issues relating to core-melt accidents raised in response to the TMI accident. An NSAC report was issued in March 1980 that discusses the safety margins available at TMI–2 under several alternative sequences of events. (127)

A more recent example of a post-incident analysis is the effort initiated in response to the February 26, 1980 transient at the Crystal River Unit 3 reactor operated by Florida Power Corporation. At the request of the operating utility, INPO and NSAC jointly assembled a team of experts with experience in appropriate technical areas. This team arrived at the Crystal River site the morning following the incident. (128)

The initial and primary purpose of the team was to provide onsite technical support to the utility. (129) It turned out that Florida Power did not need assistance in managing the transient, as it had been successfully terminated and the plant stabilized on the evening of February 26. (130) The utility, however, requested that the team stay on and perform an analysis of the event. (131)

A report of the analysis was published jointly by NSAC and INPO in March 1980. (132) The report follows generally the format of the NSAC–TMI analysis report, with an important distinction in that it also provides a number of specific recommendations to Florida Power Corporation. These indicated the need for improvements or changes in: training of plant personnel; operating and emergency procedures; plant systems and hardware; power supply, control system and instrumentation system reliability; data handling and display; and steam generator failure diagnostic system. (133)

The report was produced within about two weeks of the incident and was widely distributed to the utilities, other industry groups and the NRC. (134) Follow-up on the recommendations has involved interaction between Florida Power staff and NSAC and INPO staff. (135) The NRC found the report to be very helpful and for the most part adopted its recommendations as those to be applied to all other Babcock & Wilcox [21] plants. (136)

GENERIC SAFETY EVALUATIONS

Under this classification, NSAC has identified the following programs for 1980–81: probabilistic risk analyses, degraded core studies and class 9 accidents, emergency decision processes, key safety parameters display, and formulation of safety goals. (137) These projects are in various stages of planning and implementation.

As mentioned earlier, NSAC has performed a qualitative analysis of possible extensions of the TMI sequence of events that examines the potential for serious consequences from significant core melting. Additional work is underway to study the "progression of physical processes in core-damaging accidents" and to examine the "effectiveness and reliability of available means for terminating each accident sequence at any stage. . . ." (138)

In conjunction with Duke Power Company, NSAC has begun a comprehensive probabilistic risk analysis of one of the nuclear power plants at Duke's Oconee, South Carolina facility. (139) It is to be performed jointly by staff from Duke, NSAC and contractors, supplemented by technical staff from other utilities. (140) The study will use the WASH–1400 [22] methodology, incorporating recent advances in risk analysis methods. (141)

The study is to serve several objectives. These are: establish a benchmark for an industry study of an operating plant; improve utility industry capability in probabilistic risk assessment methods; and develop event and fault tree-based representations [23] of reactor facilities that can be used as working tools for use in evaluating operating experience. (142) The study is expected to take one year. The NSAC funding is $600,000. When the utility's commitment is added, the budget for the total effort is expected to be $1.5 to $2 million. (143)

As a result of a review of the problems encountered at TMI in the collective decisionmaking process under emergency conditions, NSAC let out a contract for a study of the potential applications of decision analysis. The contractor laid out a basic framework to show that decisionmaking in crisis situations could be approached systematically. (144) Out of this work, NSAC provided some assistance to an EEI task force that was reviewing a proposed NRC rule on emergency planning. (145) Work is continuing under the contract to develop a decision analysis framework and to evaluate in more detail its applicability to various aspects of emergency planning and decisionmaking. (146)

An area in which NSAC is attempting to pull together human factors analysis, the decision theory [24] applications, instrumentation expertise and plant operations experience is the so-called "key safety parameters display." The basic concept is to have available to operators a limited number of plant parameters on a continuous basis which would provide an unambiguous indication of the plant's status for use during transient or abnormal conditions. The NRC also has under consideration a variety of concepts and potential requirements relating to the display and communication of plant parameters for emergency decisionmaking purposes. (147)

In conjunction with several of the TMI-related subcommittees of the Atomic Industrial Forum, NSAC has been working to arrive at a technically sound and feasible approach to the selection of key plant parameters. Some discussions have been held with NRC staff to attempt to come up with one that is mutually acceptable to industry groups and the NRC. (148) NSAC is currently sponsoring work to determine which group of parameters would yield the best safety benefit. These are being tested against a number of known and postulated accidents. In addition, experiments will be conducted using nuclear power plant operators to test the effectiveness of various safety panel displays. This will be done using reactor control room simulators. (149)

Work on formulation of a safety goal for nuclear power is underway in NSAC. Preliminary concepts regarding the objectives and content of a safety goal have been presented to the technical community. (150)

RESPONSE TO REGULATORY ISSUES

The NSAC staff have participated in efforts to provide analysis and develop information in response to NRC initiatives. An example was the industry response to the issuance by an NRC staff "Action Plan." [25] (151) Under the coordination of the AIF, analysis was performed and comments provided to the NRC on several aspects of the plan. (152)

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[21] Babcock & Wilcox is a reactor-vendor of nuclear steam supply systems, among other equipment.

[22] WASH 1400, the "Reactor Safety Study," also known as the "Rasmussen report," estimates the risk to the public from a typical pressurized water reactor and from a typical boiling water reactor as a result of a variety of accidents.

[23] Two methods used in conducting risk-based safety assessments. See footnote 12, p. 335.

[24] Decision theory is the mathematical theory that supports the results of decision analysis.

[25] NUREG–0660 was issued in several draft versions for comment beginning in November 1979; the most recent version, draft IV, was issued in May 1980.

NSAC assisted in the effort to prioritize the large number of items contained in the Action Plan. An NSAC contractor had under development a systematic method for ranking proposed regulatory actions. The method, based on decision theory, evaluates proposals using a specific set of factors or attributes. The first factor is the potential for risk reduction of a proposed regulatory requirement. This is analyzed by considering the effect of the proposal on accident sequences identified in WASH-1400 as leading to reactor core melt. The method systematically considers the number and importance of accident sequences affected.

The second factor is the likelihood that the action as specified can be successfully implemented. Third is a determination whether counterproductive effects of hazards are likely to be introduced by the action. Finally, the time for effective implementation is considered. (153)

The methodology was applied to the individual Action Plan items by a task force of technical experts from industry, convened by the AIF in February 1980 as part of the overall effort to respond to the plan. The NSAC director was co-chairman, and the task force included several NSAC staff members and NSAC consultants. (154)

During this effort the task force met with the NRC staff to discuss the Action Plan and its prioritization methodology. The NRC took into account the industry's recommended priorities in deciding its own priorities, as described in Appendix B of Draft IV of the plan.

INSTITUTE OF NUCLEAR POWER OPERATIONS

INPO, an independent institute supported by the utility industry, has its headquarters in Atlanta, Georgia. Its purpose is to establish industry-wide benchmarks for excellence in nuclear operations and to conduct independent evaluations to assist utilities in meeting the benchmarks. (155) All 62 U.S. utilities that have licenses to operate nuclear reactors or that have applied for licenses have joined INPO. (156)

INPO has a 1980 budget of $11 million and is expected to have a staff of 200. (157) The Institute's organizational structure consists of a Board of Directors, an Advisory Council, an Industry Review Structure, a president and five divisions. (158)

The 11-member Board of Directors sets the policies and direction for the Institute. The members of the Board are elected from member utilities. (159)

The Advisory Council reviews INPO's programs and provides advice on broad objectives and methods to the Board of Directors. Its members will not be drawn from the utility industry. (160) Currently, it is composed of 15 prominent educators, scientists, engineers, industrialists and health specialists.

The Industry Review Structure reviews activities assigned to it by the Board of Directors. It consists of industry personnel.

The president of INPO manages the Institute's operations.

INPO's five divisions are: (161)

—Training and Education
—Criteria Development and Analysis
—Emergency Preparedness
—Evaluation and Assistance
—Administration.

The four technical divisions work closely together in setting the benchmarks and in performing utility audits.

INPO has stated that the benchmarks will not be minimum standards but optimum standards and will represent the best performance and the best thinking and experience of the industry. They will be developed based on inspections and evaluations of utilities, lessons learned from operational experiences with various incidents and from a review and evaluation of Licensee Event Reports. The benchmarks will then be the criteria against which the utilities will be evaluated. The audits and evaluations will provide the bases for ongoing improvements in individual utility programs. (162)

INPO is a voluntary organization and possesses no legal authority with which to enforce its standards and recommendations. It does, however, expect to have the full cooperation of member utilities. (163) The basis for this anticipated cooperation stems from several sources. The chairman of the TMI Ad Hoc Oversight Committee, in a statement before the President's Nuclear Safety Oversight Committee, said:

> One answer has been the establishment of Nuclear Electric Insurance Limited (NEIL), an insurance company that would insure nuclear companies against much of the higher costs of replacement energy during an outage of a nuclear unit due to an accident. One of the principal underwriting criteria for access to such insurance will be INPO's evaluation of the particular nuclear plant's compliance with all of the INPO standards. (164)

This sentiment was reiterated by an INPO official:

> . . . NEIL is absolutely going to require that any given utility meet the INPO benchmarks of excellence and the INPO standards of performance. (165)

The chairman of the Board of Directors of INPO, in an interview with the Special Investigation staff, cited the insurance issue, along with the force of public scrutiny, investor reaction and peer pressure, as factors that will insure utility cooperation with INPO. He explained that the industry will not be willing to share the risks with a recalcitrant utility, nor will investors be willing to support such a utility. He added that these forces will give INPO "clout." (166)

In a meeting with the NRC Commissioners, the president of INPO said:

> INPO will be responsive to the President's mandate to periodically inform the

> Chairman of the NRC and the Oversight Committee of our objectives, milestones, progress, and of our overall evaluation of the nuclear utility industry performance. (167)

Below is a brief description of the functions and programs for each of INPO's technical divisions. The programs and future studies of the divisions can be generally categorized according to: human elements in reactor safety (including training, human factors engineering in control room design and operating and emergency procedures); operating experience; and emergency planning and response.

TRAINING AND EDUCATION DIVISION

The function of this division is to establish educational and training requirements for operations and maintenance personnel, accredit training programs, certify instructors and provide training for utility managers in order to ensure quality in the operation of nuclear power plants.

In the area of skills training for operations and maintenance personnel, the division's first goal is to upgrade existing programs. It is reviewing the curricula, lesson plans and training materials currently used by utilities to identify the best facets of each program. (168)

In the longer term, INPO plans to define the qualification for a "fully trained and competent employee." To arrive at this it will analyze the jobs that need to be done. The work will include identification for each task, establishing performance objectives for each task and developing training programs to meet these objectives. (169)

INPO will not conduct the technical training programs but will use the material developed through its research and job analyses to make recommendations on appropriate outlines, resources and objectives for training courses. (170)

INPO is approaching this task by developing a series of training modules, which taken together will provide a complete training program for a control room operator. Each module will consist of a series of lessons and will include a description of the intended accomplishments of the module, an outline of course material, behavioral objectives, and criteria for successful completion of the module. The modules will address topics such as basic mathematics and related scientific principles, principles and operation of the thermal cycle, fundamentals of nuclear plant operations, modern physics, reactor theory, chemistry, radiation controls, operating and emergency procedures, technical specifications, reactor dynamics and simulator training. Operators will be trained in both normal and emergency conditions, including multiple failure accidents. (171)

INPO will also perform an accreditation of the various training programs, that is, examine a program's ability to produce a certain kind of training. It will review course content, the management and organization of the training program and the qualifications of the instruction staff. Before the evaluations of programs begin, INPO will establish standards and criteria against which they will be judged. INPO is working with various educational institutions and Federal agencies such as the Southern Association of Schools and Colleges, DOE and the newly-formed Department of Education in formulating these standards. (172)

INPO expects to reaccredit each training program every five years. It intends, however, to set up an annual self-evaluation program to be performed by each accredited training institution. (173)

If a utility does not meet the accreditation standards, INPO will make recommendations and provide assistance. It will identify the specific areas of weakness and help the utility to improve its program. (174)

In addition, the Training and Education Division will certify instructors and actually conduct instructor training in the form of regional workshops, training sessions and seminars. (175)

In the area of management training, INPO will develop programs for first-line managers up through the chief executive officers. INPO will not concentrate on the fundamentals of management but will focus its attention on management for safety. (176)

For first-line managers, INPO will conduct a series of workshops and seminars to provide them with better insight into problem analysis, decision analysis and command authority to help them perform better under stress. The program should also help first-line managers instill in their workers a more professional approach to operation of the plant. This attitude, INPO hopes, will filter down through all levels of management. (177)

The training INPO will provide executive-level management is aimed at helping them understand the problems arising at the lower organizational levels and committing the needed resources. The program will also provide them with better techniques for managing a crisis or emergency. (178)

The continuing effectiveness of the training programs will be evaluated not only by the Training Division but also by the Evaluation and Assistance Division through its utility audits. If the audits identify an area where the training programs are not producing the desired end result, new requirements will be proposed. Such new requirements, along with those from other sources such as the NRC or the industry, will be converted into behavioral objectives by the Training Division. They will then be passed on to the utilities in the form of new program recommendations, course outlines, training materials, etc. (179)

INPO, through its Training Division, has submitted to the NRC its April 1980 version of "Nuclear Power Plant Shift Technical Advisor, Recommendations for Position Description, Qualifications, Education and Training." (180) The NRC has reviewed and approved the use of this document, which incorporates the NRC's comments made on an earlier draft. The utilities are expected to reference this document as part of their response to the NRC Action Plan Task I.A.1 having to do with the need for a Shift Technical Advisor. (181)

CRITERIA DEVELOPMENT AND ANAYLSIS DIVISION

The primary function of this division is to develop benchmarks and guidelines for use in nuclear power plant operations. (182)

One of the major programs established by the division is the review and evaluation of Licensee Event Reports (LERs) and other significant events that relate to operations. As a starting point, INPO will review all Licensee Event Reports, outage reports, abnormal occurrence reports and data in the Nuclear Plant Reliability Data System (NPRDS) to identify generic safety issues. If an event is found to be significant, further information will be sought from the utility and the supplier of the component. In some cases an onsite investigation, such as was conducted at Crystal River, may be performed.[26] Following completion of INPO's evaluation, recommendations may be issued in such forms as new training requirements, operating procedures or maintenance guidelines. INPO will closely coordinate its activities in this area with the NSAC SEE–IN Program.[27] (183)

In addition, special studies may be required to support the division's criteria development in areas such as training and the human factors aspects of design and operation. Some topics being considered by INPO for further study include:

—Adequacy of training simulator models and techniques of simulator use. Development of performance measures and evaluation systems.

—Effectiveness of advanced instructional methods, such as computer-aided instruction and simulators.

—Psychological and physiological studies in such areas as shift rotation, attentiveness and stress.

—Communications techniques and procedures.

—Control room alarm presentation, control concepts and information processing and display.

—Methods of effective use of operating and emergency procedures.

—Detailed human factors analysis of generic operating problems.

—Stress-response testing for screening and development

—Organizational behavior and motivation. (184)

The division will also participate in the review and development of guidelines. It will examine new standards, rules and regulations being proposed by the NRC and other groups and assess their compatibility with INPO's benchmarks. The division will also compare practices at nuclear plants in foreign countries with those in the United States. (185) The division may also, as a long-term objective, prepare an operations manual for the utilities. This would include sections on various aspects of plant operations and would outline particularly effective methods for departmental organization, procedures and practices. These would not be minimum requirements or standards but models for the utilities to adapt to their own particular needs. (186)

EMERGENCY PREPAREDNESS DIVISION

Based on the experience gained from the Three Mile Island accident, INPO will try to assist utilities in the crisis management aspects of dealing with an emergency. Several specific programs are being initiated toward this end.

The division will establish and maintain a roster of technical experts in various fields who could be available to a utility experiencing an emergency. These people will come from groups such as utilities, architect-engineering organizations, nuclear steam supply vendors or consulting firms. The listing will include the individual's qualifications and abilities, as well as home and office telephone numbers, so that experts can be contacted on a 24-hour basis. (187)

The division will also maintain an inventory of emergency equipment and supplies that could be available to a utility. Since this inventory will be constantly changing, INPO's objective is to develop a list of people around the country who will know what equipment is available, where it is located and how to get it released. The inventory will include equipment in vendors' shops, plants under construction, plants in operation, National Laboratories and Federal agencies. This service will also be available to all the nuclear plants on a 24-hour a day basis. (188)

INPO is also compiling information on how to get to all the nuclear plants to assist the emergency response teams who will need to travel to the site during an incident. (189)

INPO is also working with the NRC and Sandia Laboratories on the development of the Nuclear Data Link.[28] This system would allow information regarding actual conditions at a nuclear plant to be sent directly to NRC headquarters. (190)

The Emergency Preparedness Division is examining the communications situation at nuclear plants. In an emergency the number of available telephone lines needs to be increased, and INPO is looking into ways to provide the extra capacity. (191)

The division will also prepare an Emergency Response Plan for INPO. Staff currently do not envision setting up a "SWAT team" to send to a plant during the actual emergency. However, they would have a team that could be assembled onsite within 24 hours to assist in the recovery work. This would be similar to their involvement during the February 26, 1980 Crystal River incident. (192)

INPO has prepared a document entitled "Nuclear Power Plant Emergency Response Plan," dated October 11, 1979. This generic plan is intended to provide a framework within which each host utility can structure a specific recovery organization for each operating reactor. The NRC Action Plan Tasks corresponding to this area are III.A.1 and III.A.2. (193)

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[26] See p. 339.
[27] See p. 339.
[28] See Part I, Chapter 1, "Changes in the NRC's Emergency Response Capability Since Three Mile Island," pp. 27ff.

EVALUATION AND ASSISTANCE DIVISION

The objective of this division is to identify the best nuclear power plant operating practices and to assist utilities in adopting these practices in order to improve their operations. (194) The division will have primary responsibility for conducting the annual audits of the utilities and their plants. The audits, which are expected to last one to two weeks, will take place at the utility's corporate headquarters, as well as at the plant. (195)

The audits will focus on the following areas:

1. Management and organization;
2. Plant operating practices;
3. Training and qualifications;
4. Technological support;
5. Maintenance practices and material condition;
6. Human factors aspects of designs, arrangements and practices;
7. Radiological controls;
8. Emergency preparedness;
9. Procedures, documentation and administration; and
10. In-house audit and quality assurance practices. (196)

Thus not only will the supporting areas such as management administration or training be evaluated, but the actual material condition of the plant will also be reviewed. The audit teams will check what equipment is out of service, how long it has been out of service, whether it should already have been repaired, whether it is properly tagged and whether the proper precautions have been set up. (197)

The audits will include interviews with plant personnel and may require them to describe their response to hypothetical plant situations. (198)

The audit teams will consist of approximately six members who will be drawn from the four technical divisions of INPO and will include employees on loan to INPO from the utilities. (199) The members of the audit teams will need to be experienced in plant operations and management. INPO expects to set up about six such teams. (200) It plans to have completed its first audit of each nuclear plant by July 1981. (201)

The results of the audits will be reviewed by INPO, and problems in determining the effectiveness and adaptability of various utility practices will be referred to the Criteria Development and Analysis Division for study. (202)

INPO hopes to encourage utilities to perform self-audits. (203)

ANALYSIS AND DISCUSSION

POSITIVE ACCOMPLISHMENTS

It is evident that there has been a significant response by the various segments of the nuclear industry following the accident. While it is not possible at present to draw conclusions regarding the sufficiency of the various industry actions, some positive accomplishments can be noted which certainly can be seen as improvements when measured against the situation prior to the accident at Three Mile Island.

Viewed collectively, the establishment of the various committees, groups and organizations in themselves are tangible evidence of a commitment to change. They have provided, at a minimum, new vehicles for cooperation and communication that did not exist prior to the accident. The establishment of technical aids for communication between plant staffs should improve the exchange of information relevant to safety of operations.

Previous to the accident, most of the nuclear safety analysis capability of the industry lay within the reactor-vendor organizations, certain contractors and architect-engineering firms. Much of this analytical capability was geared toward verifying compliance with NRC safety criteria. In general, only the larger nuclear utility organizations had sufficient in-house technical staff resources to perform credible independent safety review and analysis. The remainder were dependent on the vendors and contractors. The establishment of the Nuclear Safety Analysis Center is responsive to the need to strengthen the safety-technical analysis capability of the utility segment of the industry as a whole.

As industry officials are fond of pointing out, the establishment of the Institute of Nuclear Power Operations constitutes recognition of the need to strengthen both the previously neglected "human element" and the operational side of nuclear power safety. INPO is the first significant attempt by the utilities at self-regulation.

Some of the post-TMI industry-sponsored activities give promising evidence of innovation in approaches to safety thinking in the nuclear industry. Among these are the attempts to provide rational and systematic logical frameworks for prioritization of proposed safety fixes. Another is the proposed application of decision analysis methods to decisionmaking in emergency situations at nuclear power facilities. NSAC has launched trial balloons on a national safety goal that hopefully will lead to constructive discussion and perhaps to articulation of national policy. Tentative interest has been shown in examining the safety philosophies and safety management systems used in other industries and in the aerospace program in order to learn from these.

Since the publication of the "Reactor Safety Study" (WASH–1400) by the NRC in 1975, the Electric Power Research Institute has been instrumental in promoting the use of probabilistic risk-reliability theory methods in safety analysis by the nuclear industry. Since TMI, NSAC is working with utilities to build the capabilities within individual utility organizations to apply these methods.

While this study did not examine in detail the responses and improvements made by individual utilities, it was noted that a number of utilities did launch reviews of facilities and operations on their own initiative after the accident.

COMPARISON OF INPO AND NSAC PROGRAMS TO STATED NEEDS

This section reviews the industry's progress, as manifested by the programs of INPO and NSAC, in meeting the various needs identified since the TMI accident by the various investigations.[29]

The Human Element in Reactor Safety

As mentioned previously, there are three aspects to this area of need: operator training, control room design and emergency procedures.

Operator Training

Each of the investigations, as did the President's statement, stressed the need for a strong refocusing of the operator training programs. The recommendations include:

—Elevating operator pay scales
—Training by accredited institutions
—Improved control room simulators
—Emphasis on reactor accidents in training
—Substantially upgraded requirements for technical qualifications of onsite supervisors and management
—A rigorous requalification program.

The Special Investigation staff did not examine the status of changes in operator pay scales. As noted,[30] INPO plans to accredit the various training programs and then to reaccredit them every five years. The president of INPO, however, feels there may additionally be a need for congressional action:

> I can imagine Congressional action to sanctify an accreditation system so that it is accepted. (204)

Several of the utilities have purchased or are in the process of purchasing new control room simulators.[31]

The INPO accredited training programs are intended to cover the need to train operators to cope with normal operations and accidents. According to INPO's Director for the Training and Education Division:

> . . . we need to go into reactor plant dynamics, the actual operating procedures and the normal and emergency conditions for abnormal reactor operation and ultimately to tie all of this together on a plant simulator . . . everything from start-up to shut-down to loss of coolant accidents, and involvement not in single malfunctions but training and experience in multiple malfunctions. . . . (206)

As mentioned,[32] INPO is developing programs to upgrade the technical qualifications of managers at nuclear plants. They also have developed training requirements and qualifications for the Shift Technical Advisor position.

The implementation of all these operator training programs is just beginning, and the Special Investigation staff is therefore unable to judge their adequacy at this time.

Control Room Design

Again, all three investigations as well as the Presidential review found that significant attention should be paid to introducing human factors concepts into control room design. The recommendations include:

—Monitoring instruments and recording equipment should be available, along with modern techniques for displaying all critical plant conditions, including the full range of accident conditions
—Human factors engineering should be extensively applied in control room design
—In the interim a "safety panel" should be implemented
—The NRC should take the initiative to lay out minimum requirements for control room design
—Control room designs should be standardized
—Control rooms should be simplified in display and control.

While EPRI's continuing program in control room design emphasizes human factors, the programs of INPO and NSAC presently do not stress rectification of control room design deficiencies, except in limited areas.

As noted [33] in the Criteria Development and Analysis Division of INPO, the general area of control room alarm presentation, control concepts and information processing and display is being considered for further study.[34]

As mentioned earlier, a re-direction of emphasis in EPRI's research projects has led to more focus on the human factors aspects of control room design. Since EPRI work was not a principal focus of this policy study, more detailed knowledge of industry progress in this program was not sought.

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[29] This summary is essentially a scorekeeping exercise. No independent assessment has been made of the feasibility or desirability of the recommendations laid out by the three investigations.

[30] See p. 342.

[31] Out of 62 utilities with nuclear plants, 10 utilities with Operating Licenses and 9 others with Construction Permits or Limited Work Authorizations have bought or plan to buy a new simulator. (205)

[32] See p. 342.

[33] See p. 343.

[34] The AIF Policy Committee has set up a subcommittee on control room design. The Control Room Considerations Subcommittee met for the first time on July 18, 1979. (207)

In the short term, the design and characteristics of a "safety panel" are being reviewed by NSAC. Since this is a task requiring rapid industry response, and there is existing technology and expertise to be drawn on, the NSAC group has taken it on.[35] The NRC program on improved control room design is described in the NRC Action Plan. (208)

Emergency Procedures

The need to make emergency procedures more readily usable by operators and more unambiguous was highlighted by both the Special Investigation and by the President's Commission investigation.

Within NSAC, analytical methods for emergency decisionmaking are under study,[36] and exploratory calculations have been performed on variations of the TMI–2 accident to test the efficacy of alternate means of terminating an accident(s) through operator action.[37] At INPO, the Criteria Development and Analysis Division plans to study the area of writing improved emergency procedures.[38] The first step will presumably be a systematic review and appraisal of existing procedures.

The Special Investigation staff received the impression that since INPO is a relatively new organization, and staffing has been somewhat slow, little progress has been made in implementing improved emergency procedures generated by INPO. The NRC Action Plan Task corresponding to this area is Task I.C. (209)

OPERATING EXPERIENCE

The need for significantly improved programs for the use of operating experience was identified by all three of the investigations mentioned in this report.[39] Both the NRC and the industry have launched initiatives in this area. Only the industry program is discussed in this report, but it appeared to the Special Investigation staff that continued cooperation between these programs could be productive and more efficient than completely independent and redundant programs.

The investigations recommended that:

> Both the industry and the NRC continuously conduct a systematic gathering and analysis of operating experience at all plants, coupled with an industry-wide international communications network.

In addition to the NRC, as mentioned, NSAC, INPO and the utilities are also conducting reviews of data on operating experience in concurrence with this recommendation.[40] The industry programs in place in this area are relatively large and ambitious. It is still too early, however, to assess their adequacy. As time progresses, one would expect to see the number of Licensee Event Reports decrease if the programs are functioning well. On the other hand, a decrease in the number of these reports does not automatically indicate improved plant safety in a way that can be readily quantified.

Other means to monitor the effectiveness of the operating experience program may be needed. According to INPO's Director of the Division of Criteria Development and Analysis, there are several possibilities, but problems remain:

> There are measures of overall plant performance, such as outage time, availability, perhaps insurance rates, but isolating the changes in those figures due to INPO's existence will be difficult. For example, . . . the surfacing of a generic design problem may have the potential for swamping INPO contributions. . . . (210)

The Special Investigation staff had some concern that heavy reliance of all groups on the existing Licensee Event Report forms for gathering operating experience might miss some important aspects of operating experience that involve human error but that are not required to be reported. While INPO's programs will probably include interviews with plant personnel to surface problems not illuminated by the LERs, (211) the Special Investigation staff notes that other approaches may need to be considered. A report on human factors entitled "Preliminary Human Factors Analysis of Zion Nuclear Power Plant" (212) prepared for the NRC pointed out that in order to estimate accurately the potential influence of human errors on nuclear plant safety and reliability, data on human error rates are necessary. Error rates take into account both the number of errors made and the number of opportunities for making those errors. This combined information cannot be drawn from existing LER and NPRDS data. (213) The report further stated that it is important to record all errors made, whether or not adverse effects resulted, because such errors have the potential for causing such effects. (214)

EMERGENCY PLANNING AND RESPONSE

The three investigations all noted the need for industry steps to improve the emergency planning and response capabilities of the various utilities. The observations and recommendations included:

- —Unduly narrow assumptions have been made as to the kinds of accidents to be anticipated
- —There is a need for improved communication among all parties involved
- —Emergency plans must detail clearly and consistently the actions public officials and utilities should take in the event of acci-

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[35] See p. 340.
[36] See p. 340.
[37] See p. 340.
[38] See p. 343.
[39] See Part I, Chapter 5, p. 305, for discussion of the NRC's program.
[40] See pp. 339 and 343.

dents leading to a given offsite radiation dose
- —Research is needed on medical means of protecting the public against radiation
- —The public needs to be better informed about nuclear power
- —There should be a study of risks attendant with radiation-related mass evacuation
- —An industry-run offsite data center should be established.

These observations and recommendations have been responded to in varying degrees by INPO and NSAC.[41] The previous focus on large break LOCAs has been broadened to include small break LOCAs and other classes of accidents.[42] Whether the class of accidents under review now, which includes "class 9" events, is sufficiently broad to span the need for improved emergency plans remains to be seen.

The need for improved communications is being responded to in a variety of ways. The NOTEPAD system may be expanded to allow for rapid communication between NSAC, INPO and the utilities in emergencies.[43] This is not NOTEPAD's primary function, however, and NSAC does not promote its use as an "emergency management system" (215) At INPO, the Emergency Preparedness Division will keep a roster of technical experts who could be available to a utility experiencing an emergency. Hence, communication between the necessary experts and the licensee should be possible. Further, the same division is working with the NRC to develop a Nuclear Data Link to allow information at the plant undergoing an accident to be sent directly to NRC headquarters.

Innovative and more effective emergency plans are being worked on at both NSAC and INPO. At NSAC, decision theory is being used[44] in an attempt to develop an approach toward more systematic decisionmaking during an emergency. INPO has developed a generic emergency response plan[45] that should provide a framework around which individual utilities can structure their own specific response capability. The Special Investigation staff did not analyze the plan and could comment on its quality.[46]

A task force composed of members from the Atomic Industrial Forum, the Edison Electric Institute and other industry groups was formed to review the area of crisis communications. It prepared a manual entitled "Emergency Public Information Procedures for Nuclear Plants," dated January 1, 1980. The manual sets forth guidelines to help utilities establish crisis communication programs that will ensure that good information is available promptly to the public in the event of an emergency. This work is closely tied to the efforts of INPO and NSAC.

Individual utilities have been reviewing their own programs and revising them to reflect the new guidelines.

The NRC Action Plan also calls for each utility to develop improved emergency response plans, insofar as communications with NRC, etc. are concerned. (217)

Neither INPO nor NSAC have programs in response to the recommendation that research is needed on medical means of protecting the public against radiation.

Better informing the public about nuclear power so that it will be more prepared during accidents is not a job that falls within the charter of either INPO or NSAC. That task may be better suited to a group like the Atomic Industrial Forum, but the Special Investigation staff did not explore this area of identified need.

The Special Investigation staff knows of no INPO, NSAC or EPRI-related research in support of the recommendation that there be a study of the risks associated with radiation-related evacuation.

The Special Inquiry Group recommendation for an industry-run offsite data center has not been adopted by the industry. The Special Investigation staff is unaware of formal discussion within the industry on this topic.

OTHER RECOMMENDATIONS TO THE INDUSTRY

Both the President's Commission and the Special Inquiry Group investigations made industry-related recommendations outside the areas discussed above. These include:

- —Industry should set and police its own standards of excellence to ensure the effective management and safe operation of nuclear power plants
- —Management within each utility should meet uniform standards of quality
- —There should be a new level of certification for a Shift Technical Advisor to be present on each shift to direct the operation of the plant
- —Health physics practices should be improved
- —An industrywide consortium, or public corporation, should be formed to operate some plants.

The formation of INPO appears to be directly responsive to the recommendation for industry self-policing. In fact, the President's Commission recommendation mentions INPO explicitly.[47]

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[41] We hasten to reemphasize that INPO and NSAC programs, while the focus of this study, comprise only a fraction of the industry-related effort to rectify deficiencies in this important area. The NRC focus is also strong in this area, and it becomes quite difficult (and perhaps unnecessary) to sort out whether the industry is responding to NRC pressure or out of recognition of a clear need.

[42] See p. 338.

[43] See p. 338.

[44] See p. 340.

[45] See pp. 343 and 344.

[46] The plan proposes solutions to problems that were faced at TMI in the areas of internal and external communications, definition of regulatory and governmental interfaces, availability of recovery equipment and supplies, and use of specialized disciplines and skills. (216)

The notion of setting high standards for the competence of industry management is presently being dealt with by INPO's Training and Education Division.[48] Training programs for first-line management are under development. The Evaluation and Assistance Division will perform audits and determine whether the management training program has been successful at any given utility.[49] The Criteria Development and Analysis Division will, over the long run, prepare an operations manual for the utilities that will describe recommended methods for organization, procedures and practices.[50] Each utility will adapt these recommendations to its specific needs.

How well this whole system will work remains to be seen. Programs are just now underway, and the full impact may not be felt for another year or so.

Elevating the qualifications necessary for the Shift Technical Advisor has been undertaken by INPO's Training and Education Division as well; its recommendations have been reviewed and approved by the NRC.[51]

With regard to industry health physics practices and radiological controls, INPO's Division of Evaluation and Assistance will review these practices during the conduct of power plant audits. (218) If deficiencies are noted or the utility is not up to the benchmark in this area, INPO will try to help the utility correct the problem in the standard manner.

The Special Inquiry Group recommendation of establishing an industrywide consortium has not been adopted by the industry. Nonetheless, discussions are underway that relate to strengthening the weaker utilities.[52]

LIMITATIONS AND CONSTRAINTS

COORDINATION OF INDUSTRY RESPONSE

The Special Investigation staff had difficulty in identifying any single group or entity that was ultimately "in charge" of the industry's response. This is probably the natural consequence of there being so many different commercial enterprises involved, each with its own interests, and the fact that each utility is ultimately responsible for the safety of its own plant.

The Atomic Industrial Forum established a Policy Committee on Three Mile Island. It has set up many subcommittees (one of which played an important role in the formation of INPO) to respond to the needs for industry initiatives. In parallel with the formation of the Policy Committee, the TMI Ad Hoc Nuclear Oversight Committee was established. Special Investigation staff were told that this Committee had cognizance of all the industry's programs. (219) According to the chairman of the TMI Ad Hoc Committee, it was formed in April 1979 to "coordinate the industry response" to the accident at TMI–2. (220) It was this Committee that asked EPRI to form NSAC. (221) The Chairman of the Ad Hoc Committee told the Special Investigation staff that the primary role of the Committee is to be responsible for tracking the work within the industry to ensure that someone has assumed responsibility for each of the various issues that have been identified. (222) He went on to say that the Board of Directors of Edison Electric Institute had only recently extended the life of the Ad Hoc Committee for one more year. When asked whether the Ad Hoc Committee was the spokesman for the industry, the chairman said that the Committee would take the lead on broad policy issues such as prioritization of the NRC Action Plan, but that input from NSAC and the Atomic Industrial Forum Committees was equally important. (223)

The work of these two committees is not covered in depth in this report, since the focus was on INPO and NSAC. Nevertheless, it is worth noting that both Committees seem to view themselves as coordinating rather than policy formulating committees.

Hence, it appears that no single, authoritative body has assumed a strong leadership role in formulating the industry's response. It is impossible to tell whether industry initiatives (INPO, NSAC, etc.) presently are following (or anticipating) pressures from the NRC, the Congress and the Executive Branch, or whether their programs are the result of independent and objective thinking about what improved safety measures are needed. The influence of the various accident investigations is presumably another factor. In all likelihood, the industry's response is probably driven by these and other factors.

CREDIBILITY OF THE INDUSTRY

The adequacy of the safety of nuclear plants (in the absence of serious accidents) as operated by the utility industry and regulated by the NRC will be judged by the public, especially through the political process. The perceptions of the public and of local, State and national political leaders will be based in part on the documents and public statements of the industry groups.

Thus, the credibility of the groups to whom the industry has assigned leadership in improving the safety of nuclear power is important. This was recognized by the EPRI Board of Directors during discussions surrounding the establishment of the Nuclear Safety Analysis Center:

> Several directors observed that the integrity, objectivity, and credibility of the Center are of crucial importance. Cer-

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[47] See pp. 332 and 333.
[48] See p. 342.
[49] See p. 344.
[50] See p. 343.
[51] See pp. 342 and 343.
[52] See p. 350.

> tainly communication, consultation, cooperation, coordination, and collaboration with others will be necessary and desirable. However, the Center must be[,] and be perceived as[,] independent, autonomous, free of conflicts of interest and managed solely by EPRI. (224)

The ultimate effectiveness of organizations like INPO and NSAC will be determined in large part by how well these caveats are satisfied. These organizations must build and maintain trust and credibility both with the individual utilities on the one hand, and with the NRC and the public, on the other.

For example, in regard to the initiation of new programs, NSAC officials have heard comments from some utilities that indicate that there may be various levels of acceptance among the utilities. The director of NSAC summarized some of the utility statements:

> . . . "you are just going to become another NRC breathing down our necks and giving us the recommendations." On the other hand, many of them have said, "when you do one of these in-depth studies, let us work with you because we don't have the resources to do that in-house." . . . It is sort of the middle and the lower [quartile] that we worry about. (225)

The credibility of INPO and NSAC as viewed by the NRC will be determined in large part by the judgments of NRC technical staff about the quality of their work. This will be evidenced, for example, by the NRC's acceptance of INPO and NSAC work. Indications that this is occurring were gained in interviews that Special Investigation staff had with senior officials of the NRC Office of Nuclear Reactor Regulation. (226) Examples cited were the INPO recommendations for qualifications of Shift Technical Advisors, (227) and the joint NSAC–INPO recommendations following their analysis of the Crystal River transient of February 1980. (228)

Another facet of the credibility question is the perception of the "technical community" of the quality of work performed by INPO and NSAC.[53] While the two groups have not been in existence long enough to have developed a significant record in this sense, the are closely associated with EPRI, and EPRI management is sensitive to the importance of their credibility:

> That's one thing that we guard jealously. There's nothing that will wreck us quicker than to lose that. If we lose that then we're of no value to the utilities. And they know it. And that's why we have this freedom. Unless we can maintain in the technical community this aura of objectivity, there is no point in our doing work for the utilities. (229)

Among the non-technical observers of the industry's performance, the public statements and actions of industry leaders and industry safety program officials will tend to have a much larger impact on the perceived credibility of the industry than will the quality of the work sponsored by the industry. Understandably, industry leaders are proud of their accomplishments since the accident at TMI, and they want to emphasize the positive aspects of their programs to political leaders and the public.

The president of EPRI is aware that balance and objectivity are important. In this regard, he criticized a recent report by the TMI Ad Hoc Nuclear Oversight Committee: (230)

> There is a little bit too much bragging in . . . [the report] that went to the President saying how good we are and how good we're trying to be. (231)

Finally, the perceived credibility of NSAC publications may be diminished by the mixing of broad and relatively unsupported statements on the need for nuclear power (232) with the highly specific and technical focus of such publications.

RESOURCE LIMITATIONS

A commonly expressed concern of EPRI, INPO and NSAC officials has been that the individual utilities are short on manpower to implement all of the new NRC bulletins and orders, items of the Action Plan, Presidential directives and industry initiatives.[54] They maintain that there are only a limited number of qualified and experienced people in the United States on which to draw and that staffing becomes difficult.

In his statement before the President's Nuclear Safety Oversight Committee, the chairman of the industry's TMI Ad Hoc Nuclear Oversight Committee said:

> . . . the sheer volume of NRC-mandated changes [[55]] within a short time period detracts from safety. The most important short-term lessons learned from TMI have already been or are being implemented. Many of the additional measures that only, at best, marginally improve safety would dilute our efforts. Qualified manpower resources are finite. (234)

According to EPRI's Nuclear Power Division Director, the situation was evidenced by a professional journal called *Nuclear News*. He said that prior to the accident,

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[53] The "technical community" referred to here includes scientists and engineers employed by diverse organizations such as universities, DOE laboratories, contractors, research institutes, regulatory agencies, and industrial organizations, etc., who are in some way involved with nuclear science and engineering.

[54] Among these are the 23 recommendations that were included in the NSAC/INPO Crystal River report, which affect many utilities other than the Florida Power Corporation.

[55] Financial resources have been committed to implement these NRC-mandated changes. The Edison Electric Institute informed the Subcommittee that a recent compilation of data from 46 utilities identified $61 million that had been spent thus far in response to the TMI accident. (233)

> . . . [the number of people] looking for jobs was about equal to the [number of] jobs looking for people . . . At least the last six or eight issues, there has not been a single ad of anybody looking for a job . . . there are more than 12 pages of jobs looking for people. (235)

Staffing is even a problem for INPO. Its president told the Special Investigation staff that

> Unfortunately, the industry is somewhat short in personnel and therefore . . . I am constrained . . . in that I can't steal that many people all at once from industry. . . . (236)

The chairman of the Board of Directors of INPO suggested some solutions to the dilemma of how weaker utilities might cope with the manpower shortage problem:

> There are some utilities that are small that feel that the best way to achieve . . . [a high] level of technical competence is to combine . . . [their] effort with some other utilities in their geographic regions. There are discussions going on as to whether or not there shouldn't be some institutional rearranging. (237)

Because of limitations in both manpower and financial resources, a potential concern arises that the weaker utilities may have a tendency simply to continue to comply with NRC regulations, ignoring advice from INPO and NSAC.

Three factors potentially offset this concern. First, INPO, through its unofficial enforcement mechanism (indirect endorsement of the utility for membership in NEIL), may have a policing authority. Second, INPO and NSAC may be able to convince the utility that it is in its best long-term financial interest to comply with the recommendations because, ultimately, more down time would be risked from accidents stemming from inattention to the deficient areas than would be lost in making the necessary repairs. Third, peer pressure may arise from other industry groups because of the potential impact of a single accident on the entire electric power industry. Finally, investor reaction to utilities not meeting INPO standards may make it difficult for these utilities to obtain financing. Whether these forces are adequate to offset the potential problem remains to be seen.

The overall problem of resource limitations appears to be "real" in the sense that a comprehensive list of safety improvements probably cannot be implemented in a very short time. Beyond that, the Special Investigation staff is not in a position to make a judgment as to whether the problem critically affects the ability of the nuclear power industry to implement in a timely manner the recommendations of the various accident investigations (as embodied in the NRC Action Plan) and the ongoing recommendations of the INPO and NSAC organizations.

LACK OF EFFECTIVE MEASURES OF PERFORMANCE

The question of whether the industry's programs are good enough can only be answered once their objective is clearly stated and a means has been developed to evaluate the impact of their programs in meeting the stated objective. This set of constraints, while superficially obvious, poses a number of problems.

Even if a safety objective could be articulated and agreed upon, measuring overall performance of industry-initiated programs may be difficult for several reasons. First, NRC's involvement and influence on safety cannot be isolated from that of the industry. In all of the important areas that have been identified as appropriate for industry attention,[56] there is a corresponding NRC "Action Plan" area (238) that addresses the same issue to some degree. For example, the INPO and NSAC operating experience evaluation programs are paralleled by NRC's programs (Action Plan Task I.E.). If a quantifiable and measurable improvement in safety could theoretically be attributable to the overall program, it would be difficult to decide how much should be attributed to the industry and how much to the NRC. Similar circumstances prevail in the areas of operator training, control room design, emergency procedures and emergency planning and response.

Another dilemma in measuring industry performance arises if the safety goal is too broadly defined. For example, if the industry-proposed safety goal [57] were adopted, the final evidence of success or failure in meeting it will depend on an event that might not occur for tens of years. On the other hand, a safety goal that monitored the frequency of more probable events (for example, reactor scram frequency or safety system actuation) could be more readily measured and performance monitored, but may have less immediate and obvious implications to the ultimate safety of the public.

Without some mechanism of positive feedback, there is a concern that continued diligence toward improving safety may suffer. Lacking a clearly stated safety goal and a stated intention to monitor whether or not steps are being taken to meet it effectively, the industry groups (INPO and NSAC) and the NRC might continually ask individual utilities to make changes until they are no longer motivated to cooperate. If, for example, a given utility could work toward a set of objectives that was clearly identified and readily monitored, it might be more motivated to perform well than if it were forced to remain in a strictly defensive posture, reacting to numerous open-ended directives of both the NRC and the industry while trying to remain viable financially and operationally.

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[56] See pp. 327 and 334.

[57] No core-damaging accidents within 30 years with 99.9 percent probability that radiation release will lead to less than a 1-rem dose to any member of the public. (239)

CONCLUSIONS AND RECOMMENDATIONS

The adequacy of the industry's programs will continue to be examined in the context of unresolved public policy issues that bear directly on the need for a given level of industry performance. Since complete resolution of the issues is not likely in the near future, the task of assessing the performance of the industry in implementing its newly mobilized programs will remain an ongoing activity with continually changing public policy ground rules.

Continued oversight is called for. Both the Congress and the newly-formed President's Oversight Committee should keep an eye on industry progress. The nuclear industry already has begun briefings for the President's Committee. (240)

The Subcommittee may wish to consider the usefulness of reinstituting the "202 hearings" that were held by the Joint Committee on Atomic Energy. This concept, suggested to the Special Investigation staff by an ex-NRC official, (241) would afford an opportunity for the Congress, the NRC and the industry to meet once a year or so to identify areas where work is needed. If the NRC and industry are at an impasse on some issue, the Congress should be advised. If more progress is needed in an area of industry responsibility, that should be identified. And so forth. This step certainly will not solve all of the nation's reactor safety problems, but might help ensure that the NRC and the industry communicate periodically and confront and resolve differences of technical opinion.

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232. Op. cit., Edwin L. Zebroski, NSAC, "A Proposed National Nuclear Safety Goal," March 1980, presented at the 7th Energy Technology Conference in Washington, D.C., May 24–26, 1980, pp. i, 1–2; Edwin L. Zebroski, NSAC, "Lessons Learned and Lessons Not Learned in Reactor Safety," presented at American Association for the Advancement of Science, 1980 Annual Meeting, January 7, 1980, pp. 4–5, 15.

233. Op. cit., Letter from John J. Kearney, EEI, to William G. Ballaine, TMI Special Investigation Staff, June 9, 1980, p. 1.

234. Op. cit., Lewis Statement, p. 15.

235. Op. cit., TMI Levenson Interview, pp. 60–61.

236. Op. cit., TMI Wilkinson Interview, p. 3.

237. Op. cit., TMI Lee Interview, p. 5.

238. Op. cit., NRC Action Plan.

239. Op. cit., Edwin L. Zebroski, NSAC, "A Proposed National Nuclear Safety Goal," March 1980, presented at the 7th Energy Technology Conference in Washington, D.C., May 24–26, 1980.

240. Op. cit., Lewis Statement.

241. Op. cit., Memorandum of Telephone Conversation between L. Manning Muntzing, Doub and Muntzing, and Jay Boudreau and Joan Giannelli, TMI Special Investigation Staff (CIT), February 19, 1980.

Chapter 2

Insurance for Replacement Power Costs

By

Katherine W. Kimball

INTRODUCTION

The accident at Three Mile Island has demonstrated that the burden of purchasing replacement power can have a severe financial impact on a major utility system.[1] With the loss of TMI Unit 2, and the consequent shutdown of Unit 1, the GPU system's replacement power costs during 1979 ran from $20 million to $35 million per month, with high continuing costs forecast for 1980 and beyond. (2) These and other accident-related costs have had several repercussions. First, State regulators have been put in the difficult position of balancing how much extra expense a utility can absorb without going bankrupt against how much more ratepayers should be forced to pay for their electricity. The dilemma was serious enough for the Pennsylvania Public Utility Commission (PaPUC) to express an interest in having the Federal government take a more active role in this balancing process and perhaps alleviate some of the strains of decisionmaking. (3) Second, the utility's condition has raised concern over its ability to pay for all the cleanup costs. Third, the PUC must still provide service to its customers at reasonable rates. Finally, the Nuclear Regulatory Commission (NRC) could be subject to pressures because of the tremendous potential financial impact of its actions with respect to both the nature and the timing of NRC decisions on the restart of TMI Units 1 and 2. The staff is unaware of any actual influence these considerations have had on NRC decisions to date.

Recognizing the post-accident financial difficulties facing the GPU system, utility groups have established Nuclear Energy Insurance, Ltd. (NEIL), an organization designed to provide replacement power insurance in the event of extended outages at nuclear plants. NEIL is a Bermuda-based mutual insurance company which is currently proposing to offer $156 million of insurance to domestic commercial nuclear facilities over a period of six months to two years. (4)

This type of program holds the potential for greatly reducing the extraordinary financial stress placed on utilities as a result of an accident. In addition, NEIL could serve as a safety incentive to utilities by offering a much-desired benefit only to utilities that meet certain safety standards. It is too early to tell whether these will in fact be the results of the NEIL effort. Nonetheless, with the organization still in its early stages, now is an appropriate time to analyze the NEIL program to assess its merits and potential.

PRIOR TO TMI

In the 1950s, when nuclear-generated electricity was first being developed, utilities considering nuclear power plants wanted assurances that they would not be opening themselves up to more liability than they could afford. (5) Some insisted that, in the event of a serious accident, their liability to the public for personal injury or property damage could be practically unlimited. (6) At that time, private insurers were willing to offer utilities only $60 million in insurance,[2] considered to be a small fraction of the liability that could result if a serious accident were to occur. (7)

Utilities sought the aid of the Federal government, which provided up to $500 million in Federal indemnification to cover liability expenses resulting from a commercial nuclear accident. (8) Congress, through the Price-Anderson Act, also set a limit on liability for any accident equal to the total amount of funds available—then $560 million.[3] Price-Anderson now provides for a three-tiered system of annual premiums, retrospective premiums (premiums assessed only after an accident has occurred and more funds are needed), and government indemnity payments to provide compensation to the public in the event of a nuclear accident at a facility covered by the Act.

A second concern of utilities considering nuclear-generated electricity was that damage to onsite property would also be high. Here, utilities found that private insurance pools were prepared to offer $63 million in coverage in the first year.[4] (11) Since property damage was considered likely to be less extensive, no Federal aid was sought in this area.

Thus, by 1979, when the accident at Three Mile Island occurred, nuclear utilities were covered by both liability and property insurance. However, there was one area in which accident-related expenses were expected to be high but no insurance arrangement had been made: replacement power costs.

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[1] General Public Utilities is the holding company for the owners of TMI, Metropolitan Edison and two other utilities. The GPU system, the 14th largest in the country, is clearly in financial straits. For more information, see the report of the Senate Special Investigation on Three Mile Island. (1)

[2] Now $160 million plus retrospective premiums.

[3] The latest Price-Anderson amendments provide that the limit on liability may increase once private insurance has absorbed the government indemnity. Annual insurance premiums now pay for $160 million in private liability insurance. Retrospective premiums are to be assessed at $5 million per accident per 100mw or larger facility. At present, a total of 67 operating reactors would be assessed at $5 million each, making a total of $495 million in retrospective premiums plus private liability insurance. As more plants begin operating, more money can be obtained from private sources through the retrospective premiums, eliminating any Federal indemnification and eventually providing an increasing amount of money to pay public liability claims. The government at this time is potentially liable for the remaining $65 million. (9)

[4] This coverage has now increased to $300 million. (10)

This problem was predicted in 1975 by William Anders, former Chairman of the NRC, when Congress was considering whether the financial risk to utilities under Price-Anderson should be increased:

> Apart from NRC regulations, licensees have a very substantial and direct financial interest in safe operations. If a nuclear plant is inoperable, power must be purchased from other utilities to meet customer needs. Losses can run to the millions of dollars if a plant is shut down for a substantial period. (12)

This observation was echoed in the same context by Hubert Nexon, senior vice-president at Commonwealth Edison Co., who would become one of the leaders in the post-TMI move to provide replacement power insurance. In 1976 Nexon stated:

> [T]he utility would suffer severely from increased operating costs, over $1 million a week, because of the substitution of more expensive generation or purchased power for the output of the lost unit. (13)

The problem of replacement power thus was recognized, but as the quotes suggest, the upper range of potential costs involved may not have been. In any event, the need for insurance was discussed, but no program was developed.

The accident at TMI finally revealed just how staggering replacement costs might be. This dire example prompted industry personnel to take immediate steps to develop insurance to cover this type of liability.

FORMATION OF NEIL

The TMI Ad Hoc Nuclear Oversight Committee, an industry group formed by Edison Electric Institute [5] to respond to the events at TMI, was the first industry group after the accident to begin discussing some form of replacement power insurance. (14) One of its subcommittees, the Financial Considerations Committee, chaired by Hubert Nexon of Commonwealth Edison, focused on this issue and estimated how much insurance could be offered and how much utilities could reasonably afford to pay for both annual premiums and for the type of additional retrospective premiums (15) that might have to be assessed should an accident take place.

On July 25, 1979 Edison Electric Institute sent out a nuclear insurance questionnaire to approximately 60 nuclear utilities. (16) Forty-two responded, indicating widespread interest in a number of replacement power insurance options. (17)

COVERAGE

Membership in NEIL is open to any

> utility located in the United States which has an insurable interest in, or in the output of, a unit in commercial operation and which meets the financial responsibility and underwriting standards established by the Company. (18)

NEIL presently offers its members (now numbering approximately 30) a maximum coverage of $156 million per outage. (19) There is a six-month deductible period, during which the utility receives no payment for replacement power costs. Thereafter, those utilities which have chosen the maximum available coverage will receive $12 million per week (or 90 percent of actual costs, whichever is less) for one unit for the first year. (20) The percentage of coverage decreases with each additional unit, with only 50 percent of the selected indemnity provided for a four-unit site. (21) During the second year, the member will receive 50 percent of its selected coverage ($1 million per week for the maximum coverage), providing a maximum of $156 million per outage over a period of 2½ years. (22)

At TMI, for example, if GPU, which has joined NEIL, had had the maximum amount of NEIL coverage for Unit 1, NEIL would have paid GPU, after the six-month deductible period, 80 percent of the selected indemnity for the unit.[6] GPU conceivably could have collected 80 percent of $2 million (the maximum weekly indemnity) for each of the units, or $3.2 million per week for both facilities. Since coverage decreases by 50 percent during the second year, GPU could have recovered $1.6 million per week during that time. The total recovery from NEIL over the 2½ year period thus could have been $249.6 million.

As of early June 1980, GPU estimated that it had paid about $300 million for replacement power. (23) Clearly, NEIL would not have covered even a significant portion of actual replacement power costs.

Policies may be suspended if NEIL asks the member to correct a "dangerous condition" as yet undefined, and the member were to fail to do so. (24) No other safety-related criteria have been set by NEIL at this time. Even if its policy is suspended or cancelled, a member still remains liable for the retrospective premium if losses occur during the term of the policy. (25)

PREMIUMS

Annual premiums for the maximum coverage are $1.51 million per year for a single unit site. (26) They may vary at a site with more than one unit, depending on the "degree of physical interdependence among units." For example, for a two unit site, the annual premiums range from $1.56

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[5] Edison Electric Institute is the trade association for investor-owned electric utilities.

[6] TMI is owned by three subsidiaries of GPU: Metropolitan Edison, Jersey Central and PENNELEC. Presumably GPU would pass on any insurance payments to each subsidiary in proportion to their investment.

million to $1.69 million. (27) A site such as TMI, where the two units are highly "interdependent," would probably be assessed premiums of close to the maximum $1.69 million per year. Exact standards on the degree of "interdependence" have not yet been released.

Utilities owning only part of a nuclear plant may also receive NEIL coverage. If the unit experiences a long-term outage, each utility with an interest in the facility receives its *pro rata* share of the coverage. (28)

In addition, there is a one-time reserve premium exacted when members are first insured in order to establish a reserve fund. This premium is not to be greater than 13 percent of the regular annual premium. (29)

Finally, a retrospective premium adjustment will also be assessed in the event of an accident. This is limited to five times the annual premium. (30) Liability for the retrospective premium will cease six years after the policy year, unless demand for its payment is made beforehand. (31)

MANAGEMENT

The Board of Directors of NEIL has authority to manage it and to appoint officers. According to the Information Circular:

> It is presently anticipated that each Member will have a representative on the Board of Directors, subject to limitations on such representation where a Unit or site is owned by more than one Member. (32)

Two directors must be residents of Bermuda: they will be the only directors to receive remuneration. (33) Management services will be provided by Marsh & McLennan (Bermuda), a U.S. insurance brokerage firm that is a major broker of nuclear insurance. (34)

Under NEIL's bylaws, the Board of Directors appears to have a wide range of authority over the activities of the company. It can:

> . . . pay all expenses, . . . exercise all such powers and do all such acts and things as may be exercised or done by the Company and are not hereby or by statute expressly directed to be . . . done by the Company in General Meeting . . . borrow money . . . [and] fix and change criteria, procedures and regulations for the establishment of the rates of premiums . . . [and] the risks to be covered. (35)

Members' voting rights are set according to each member's relative premium obligation, with one vote per $10,000 of the retrospective premium adjustment. (36) Bermuda law requires that no single member have more than 9½ percent of the votes, this in order to prevent the company from being considered a "foreign" (i.e., non-Bermuda) corporation. Since each member must be a U.S. utility, NEIL will be controlled by a group of, rather than any individual, foreign corporations. Annual meetings will be held at which the members shall

> . . . receive the annual financial and operating reports of the Company for the preceding fiscal year, elect the Board and act on any other such matters as may come before them at such meeting. (37)

LOCATION

NEIL is based in Bermuda, rather than in the United States, for a variety of reasons. Peter Lederer, NEIL general counsel, suggested that the location was chosen because the capitalization requirements for mutual insurance companies were lower than in the U.S. (38) In addition, the NEIL Information Circular indicates that Bermuda does not assess any income tax. (39) The combination of ease of establishing such a company and the absence of taxes are obvious inducements to locate in Bermuda.

NEIL will have to take certain precautions in order to maintain its status as a Bermuda company, including the following:

> (1) NEIL will have to maintain its principal office and principal representative in Bermuda and have no office or other fixed place of business in the United States;
>
> (2) It must always have on hand a specified surplus of not less than $250,000; (40)
>
> (3) At least two of the company's directors must be residents of Bermuda; (41)
>
> (4) Independent contractors, rather than NEIL employees, must be used for rating and claims adjustment tasks performed in the U.S.; (42) and
>
> (5) As stated previously, no single NEIL member can control more than 9½ percent of the voting rights. (43)

If NEIL adheres to these five requirements, it is the opinion of its counsel that it will be considered under both Bermuda and U.S. law to be a Bermuda company not doing business in the United States. (44)

INVESTMENTS

Funds will initially be invested outside the United States in short-term bank obligations. As a result, NEIL's counsel says the U.S. will impose no tax on the profits. (45) No investments will be made in any NEIL member.

Members will determine the disposition of any profits at general meets. (46) Any profits that the members decide to distribute will be in proportion to the member's interest in the company's net worth. (47) The NEIL Circular states, "It is anticipated that in the initial years of the Company's operation a major portion, if not all, of any profit would be retained for surplus." (48)

PRESENT STATUS OF NEIL

RESPONSE BY UTILITIES

Reports from NEIL's latest meeting held in Toronto on May 29, 1980, indicate that 30 utilities have submitted applications. (49) Once accepted by NEIL, these utilities would together be allocating funds totaling $75 million. (50) However, some utilities are waiting for a ruling from their State Public Utility Commissions (PUC) on whether the insurance premiums will be considered legitimate operating expenses, payable by the consumer. (51) Without these utilities, NEIL would have funds totaling $46 million, which is below the $50 million minimum they claim they must have in order to commence operations. (52) Until these outstanding utilities can get approval from the PUCs, NEIL will have to postpone its startup date.[7]

PUC APPROVAL

As noted, the question of how a State Public Utility Commission will treat the NEIL premiums is open. Traditionally, most State utility commissioners have treated insurance premiums as reasonable operating expenses that can be passed on to the consumer. (53) In some States, however, the PUC takes a closer look at the type of insurance, how much the premiums are, for example, and only then makes an evaluation. (54) With millions of dollars now at stake, utilities needing their State PUCs' approval will be anxious to receive it before committing funds to NEIL. This is a major factor in NEIL's inability to begin operations at this time.

In some cases, prior approval is needed only for the retrospective premiums. Still, utilities cannot become NEIL members without a commitment to this premium. (55) According to William Beyer, former Director of Administration for the Institute for Nuclear Power Operations, the retrospective nature of this premium is a larger problem for publicly-owned utilities because of State prohibitions against lending public funds to private enterprise. (56) According to NEIL's counsel, State procedures vary widely, one reason it has taken applicants so long to respond to NEIL's invitation. (57)

Another potential difficulty is that NEIL calls for utility executives to serve on its Board of Directors. This may also require PUC approval. (58)

PUBLIC UTILITY PROBLEMS

William Beyer, among others, has suggested that another problem public utilities[8] may have is that the retrospective premium would require that the utility commit its public funds beyond the current fiscal year, which may be considered a violation of the proscription against lending of public funds. (60) To date, NEIL has not written a legal opinion on this issue.

In response to this problem, three public utilities (Nebraska Public Power District, Omaha Public Power District and Sacramento Municipal Utility District) have taken the lead in developing their own insurance to cover "continuing expenses" which does not carry with it the retrospective premium. (61) These utilities, through the American Public Power Association (APPA)[9] have been working over the past year to develop private insurance that is not mutual and that requires only annual premiums. (62) They hope to offer $50 million in coverage, but as yet have only $20 million available. They hope enough additional coverage will be secured by the end of the summer so that they can issue policies. (63)

The APPA plan has sought and received considerably less attention than the NEIL program, perhaps because it is serving the needs of only publicly-owned electric utilities. It appears at this point, however, that it may be as close as NEIL to commencing operations. (64)

Whatever type of insurance ultimately becomes available, the trend may be toward more coverage for nuclear utilities. Since TMI, electric utilities have to contend with the financial community's skepticism of the safety of nuclear power. As time goes on and more utilities seek the security of insurance protection, potential investors may view insurance as a prerequisite to allocation of their funds. (65)

TIES WITH INPO

One aspect of NEIL of particular interest is the extent to which it may offer a safety incentive to those nuclear power plant owners eager to participate in its insurance program. If NEIL coverage is available only to those plants receiving an acceptable rating from the Institute of Nuclear Power Operations (INPO), an industry group attempting to establish "benchmarks of excellence" and perform independent audits of nuclear power plants, a utility is more likely to strive both to meet and maintain those standards than they might otherwise.[10] In a presentation before the New York Society of Security Analysts in November 1979, William S. Lee, Board Chairman of INPO, stated that when INPO is in operation, "it is visualized that insurability [under NEIL] will be tied to INPO certification." (67)

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[7] This date has been changed several times. It was set at the November 16, 1979 Steering Commission meeting in Toronto as April 1, 1980. At the February 29, 1980 meeting, it was pushed back to May 15 or June 1, 1980. That date has come and gone, and NEIL is still not operating.

[8] There are currently approximately 32 publicly-owned electric utility systems with an interest in nuclear power plants. (59)

[9] The American Public Power Association is a national service organization which represents public power systems in all parts of the United States.

NEIL's Information Circular of December 1979 states that

> In order to be accepted as a member, each applicant must also meet such standards of insurability as the company will establish with respect to the premises to be insured, the qualifications of personnel, and operating and maintenance practices. It is anticipated that in developing such standards, the company (NEIL) will require adherence by the members to relevant industry guidelines established by the Institute of Nuclear Power Operations and similar organizations. (68)

The staff of the NRC prepared a memo in January 1980 repeating the language in the NEIL circular and concluding that the NEIL proposal had "considerable merit" because it would "provide not only reasonable assurance that replacement power costs could be covered by a licensee, but would also provide additional safety assurances as established by INPO." (69)

In a Subcommittee interview in March, Bill Beyer, former Director of Administration for INPO, indicated a similar perception of the ties between the two groups: ". . . NEIL is absolutely going to require that any given utility meet the INPO benchmarks of excellence and the INPO standards of performance." (70)

Those directly involved with INPO and NEIL have not finalized what the tie between the two groups should be. In a statement before the NRC in March 1980, Bill Lee of INPO stated that ". . . NEIL has agreed with INPO in concept to make a tie at the appropriate time in the future." (71)

John Ahearne, Acting Chairman of the NRC, explained that his understanding was that INPO would be explicitly tied to insurance. Eugene D. Wilkinson, President of INPO, stated, "I think in the early discussion, that is correct." (72)

In May 1980, those involved in the development of NEIL were still formulating the nature of the relationship, according to Lederer. (73) NEIL will rely, in part, on the INPO reports if it believes that these reports are useful. Lederer declined to make a judgment at this time whether or not these audits would in fact be used, although he considered it likely. (74) Before INPO has completed its audits, or if they do not prove adequate, NEIL will rely on standard nuclear insurance indicators which focus on less technical issues such as fire hazards, rather than the level of safety maintained by the system. (75) As noted, the present policy has not safety requirements for membership in NEIL. Any decision to tie NEIL coverage explicitly to INPO reports will have to be approved by the Board of Directors. (76)

Jack Pfister, General Manager of the Salt River Project and a member of INPO's Steering Committee, has stated that there may be antitrust difficulties in maintaining explicitly close ties between the two groups. (77) Lederer suggested that antitrust problems may arise if satisfactory performance in INPO is a prerequisite to participation in NEIL,[11] as such an arrangement could have an anticompetitive influence.

However, NEIL's counsel Lederer has indicated that this is not a serious problem, since "there is an overlap of interest and not identity." (79) Lederer stated that INPO is likely to encompass a "larger universe" than NEIL, since INPO will be involved with all U.S. reactors, as is NEIL, plus nuclear facilities under construction. (80)

Beyer did some research in this area. He has stated that the anti-trust issue should not be a stumbling block between the two groups because public policy would favor a close association between them in the interests of safety. (81)

Testifying before the NRC, Lee stated:

> . . . NEIL has agreed with INPO in concept to make a tie at the appropriate time in the future. . . . With or without that tie, we are satisfied that every utility will be very highly motivated to conform with INPO's recommendation for improvements. (82)

In an interview with Subcommittee staff, Lee indicated that, even without NEIL, utilities will be motivated to participate in INPO and meet its safety standards because of public scrutiny, peer pressure and investor reaction. (83) In addition Lee stated that:

> In the wake of TMI, utilities have the advantage of the hype of the situation, and each is committed not to let it happen here . . . Some years from now, when the shift operator may not have the post-TMI adrenalin, INPO will be there to assure that all aspects of operation and training are of the top quality necessary to give assurance of safety. (84)

He did not believe, therefore, that it was important to tie NEIL membership with the "standards of excellence" being developed by INPO.

Although these factors may in fact provide the necessary impetus for utilities to join and remain members of INPO, all of them hinge on the assumption that the lessons of TMI will continue to motivate the utilities for years. If the "post-TMI adrenalin" is exhausted, however, the utilities' eagerness to meet INPO's safety standards may flag, rendering INPO ineffective as a means of ensuring high levels of safety in nuclear power plants. Moreover, a close tie between membership in NEIL and INPO would constitute public acknowledgement by nuclear utilities that INPO will continue to be relied upon to assure high safety standards within the industry.

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[10] The industry has also developed another organization called the Nuclear Safety Analysis Center, whose function is to analyze and establish technical safety standards for nuclear power plants. INPO, on the other hand, focuses on operational aspects of nuclear power plants. (66)

[11] According to American Nuclear Insurers, inspectors review, among other things, quality assurance programs and radiological protection systems, with an underlying emphasis on fire protection. (78)

Whether or not there should be a close connection between the two groups remains a difficult question to answer, as Lederer has pointed out, until INPO releases more information about what form its audits of utilities will take.[12] If INPO's audits are going to be in "report card" fashion, there may well be a benefit in a close association between INPO and NEIL. This connection would give information to utilities regarding specific deficiencies, if there were any, and utilities would understand that they must meet INPO's standards or lose their replacement power insurance. This would provide INPO with a lasting financial incentive that would aid INPO in maintaining truly high standards. (85) The combination of a truly high set of INPO standards and NEIL's insurance could help utilities reduce the possibility of an accident (via INPO audits) and at the same time reduce the financial burden of those who do suffer a long-term outage. Utility executives would thus be induced to choose membership in both organizations.

WHO SHOULD PAY?

The accident at TMI amply demonstrated the tremendous burden utilities must bear for replacement power costs. For more than a year, the New Jersey and Pennsylvania Public Utility Commissions have had to find a balance between keeping the GPU companies solvent and setting reasonable rates in the face of enormous, unanticipated extra expenses. (86) Thus far the regulators have obligated ratepayers to pay a substantial share, but not all, of the cost of purchasing replacement power; the utilities have had to absorb at least some of the replacement power costs, as well as the capital and operating expenses associated with the TMI units, including cleanup costs. Thus both the GPU system companies and the ratepayers have had to contribute to the staggering costs facing the utility.

Efforts to spread the financial burden further have failed thus far. The Pennsylvania Public Utility Commission asked the President and the Congress to step in and help them find a satisfactory solution to this unprecedented problem:

> . . . we find the Federal response . . . to be woefully inadequate at a time when the owners of the plant, the utility ratepayers, and a consortium of bankers are acting as surrogate insurers of a nuclear accident which may yet threaten to bankrupt three major electric utilities.
>
> We again urge President Carter and the United States Congress to recognize their responsibility and use their power to minimize the financial burden of this unfortunate accident. (87)

The GPU companies so far have been similarly unsuccessful in their attempt to reduce the price at which they purchase replacement power from the Pennsylvania-New Jersey-Maryland Interconnection Pool, an arrangement which would have reduced the revenues of pool members selling power to the strapped GPU system and thereby increased the bills of the consumers of each pool member. (88)

How will NEIL change this picture? First, NEIL is offering coverage for only a small percentage of replacement power costs [13] and thus will not have a significant impact on total costs. If there is another TMI, decisions still will have to be made after an accident on how to apportion the burden of substitute replacement power costs that will not be paid for through insurance. On the other hand, there may be a benefit to the limited coverage NEIL is offering. Limited insurance coverage for potentially unlimited costs may provide another safety incentive to utilities. If NEIL in fact covered 90 to 100 percent of the replacement power costs, their great safety incentive might be removed. Nonetheless, NEIL, as it is presently structured, may be useful for its effect of forcing PUCs to focus on what to do, and to anticipate and apportion accident-related costs before an accident occurs. In many cases, utilities covered by NEIL coverage will have approached their PUC for rate relief to cover the insurance premiums; thus the Commission will have had an opportunity to consider the issue of whether utility customers should help pay these costs and whether money should be paid now in order to relieve the cost that might have to be borne if an accident were to occur in the future.

The PUC's may view NEIL as a good faith effort on the part of nuclear utilities to bear the risk internally, which may make them more disposed to make a decision favorable to an injured utility.

The presence of insurance, however, may make any decision by a PUC more complicated. First, the issue of the premiums will be presented to a PUC. Second, the PUC must at a later point decide who should bear the burden for expenses incurred during the six-month deductible period. Third, a decision must be made regarding the expenses that exceed the cost of coverage. In addition, there remain the problems seen earlier of who should pay for the difference in cost of replacement power and who should pay for the cost of cleanup.

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[12] No attempt is made here to assess the quality of the product INPO may produce.

[13] NEIL is offering $156 million in coverage, whereas replacement power costs for TMI (both units 1 and 2) have been running from $20 million to $35 million each month. (89)

The question of who should pay for replacement power (either the insurance or extra cost of the electricity) is a difficult one replete with far-reaching implications. There are four possible sources of funds to pay for this extra expense: (1) the injured utility, (2) a utility's ratepayers, (3) all nuclear-generated electricity consumers, or (4) the Federal Government (all U.S. taxpayers).

A decision should consider a number of important factors: predictability, safety, risk-spreading, ability to pay, corporate responsibility and attitudes toward nuclear power. Each of these factors should be taken into account by a PUC when it decides who should pay.

A PUC may decide that the utility should absorb the cost of replacement power. This alternative is unlikely because of the tremendous financial burden an accident is expected to impose on utilities. PUC's are extremely reluctant to help push utilities toward bankruptcy since part of their mandate is to ensure continued service. While modern bankruptcy laws often call for reorganization rather than cessation of business (no U.S. utility has ever ceased to provide service because of bankruptcy), PUCs are anxious to avoid any responsibility for the financial collapse of a utility.

With an insurance plan such as NEIL, however, PUCs are not left with an all or nothing situation. They may choose to have utilities pay for replacement power during the deductible period, or after the coverage ceases, or both. This would limit the financial strain on utilities without removing the safety incentive which might otherwise be the effect of an extensive replacement power insurance coverage. This approach would also encourage corporate responsibility by forcing nuclear utilities to absorb more of the costs of their externalities. Predictability would only be increased if the PUC decided beforehand that in the event of an accident, consumers or some group other than the utility will pay only for the cost of the insurance. Clearly, risk-spreading would not be maximized in this instance.

If a utility's ability to pay is limited, as is the consumer's, it is difficult to assess which of the two is more able to absorb what costs. While the cost per consumer would be significantly less than the cost to the utility, consumers' assets are also likely to be significantly less than those of a utility.

The effect on nuclear energy of a PUC decision requiring utilities to absorb some or all replacement power costs is uncertain because there are practically no new orders for nuclear power plants today.

A PUC decision requiring utilities to absorb some or all replacement power costs would be a factor to be taken into account when investors consider expending funds on nuclear plants. This perceived increased risk will probably have the effect of increasing the cost of capital for utilities, an increase which PUCs uniformly pass on to ratepayers. Thus, ratepayers would ultimately pay more if utility executives chose nuclear in spite of the additional costs, but the onus is on the utility executive to take into account this increased cost before deciding whether to build more nuclear power plants or making any capital-intensive changes in existing ones.

This approach could discourage utilities from building more nuclear power plants, but orders for new ones have already declined significantly in the last several years, so that the effect on existing plants is not likely to be substantial.

The second option facing the PUC is for the utility's ratepayers to absorb the bulk of the extra costs. This option is the one chosen by the Pennsylvania PUC and is the most likely outcome of these types of rate cases, barring Federal intervention.

As TMI demonstrates, this decision is not very predictable, since the PUC can only make this decision after an accident and after the utility has come to the Commission asking for a rate increase to cover these costs. If some or all of the costs are automatically passed through, the effect could be to remove a safety incentive. Since a utility cannot be sure before the fact that the PUC will arrive at this decision, the uncertainty may provide the safety incentive.

This alternative does spread the risk more, but conversely decreases the amount of corporate responsibility, although the effects of an accident are at least localized.

A balancing of these two values will have to turn on the facts of each particular case. The ability to pay issue is similar to the one in the first situation: incremental costs for households with sometimes very limited incomes vs. enormous costs for a utility with sizable assets.

The effect of a decision to pass through costs to consumers will probably be felt in two stages. First, before a PUC decision is made, the cost of capital will rise, perhaps dramatically, for the utility. Depending upon the time lag between an accident and a decision, the resulting increased cost of capital may or may not be passed on to consumers. Second, after a PUC decision to pass through these costs is made, investors may feel much more reassured, thus driving down the cost of capital. If there should be a series of accidents involving replacement power insurance, the evolving trend of PUC decisions could become crucial. For example, if PUCs routinely take as long as they did in Pennsylvania to decide who should pay, investors may be hesitant to make their funds available to nuclear utilities.[14] If on the other hand, PUCs make decisions soon after an accident to pass through costs, lenders may be less hesitant.

The third option, represented by NEIL, is for all nuclear ratepayers to absorb the cost. This is one of the most predictable methods since arrangements for payment are made ahead of time. Its application may be limited, however, depending upon how much insurance is offered. The effect on safety, as is discussed above, may also depend upon how much insurance is offered.

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[14] It is important to note here the two-way cause and effect relationship between Wall Street and PUCs. If, in ruling, a PUC is trying to reach a decision on replacement power costs, investors are clearly backing up a utility that has suffered a serious accident, the PUC will be likely to consider that fact in its decision.

If a goal is to spread the risk, this third alternative achieves that goal better than the others. Again, the converse point is raised that it diminishes corporate responsibility and asks "consumers in Iowa to pay for an accident in Maine."

Spreading the risk also increases the pool of people raising (presumably) the same amount of money.

Utilities may well prefer this approach, as it gives them access to more ratepayers and possibly access to more money. An incremental cost to all nuclear ratepayers would be much easier to achieve than a large increase in a localized population such as the residents around TMI.

The last alternative is for the Federal government to intervene and provide replacement power funds. Predictability here varies with the approach taken by Congress. If an act like Price-Anderson is passed before an accident asserting Federal liability for some or all funds, there will be a high degree of predictability. If, on the other hand, Congress chooses to do little beforehand, the utility will be very unsure of the outcome until an accident has occurred, similar to the position a utility is in when waiting for a PUC decision.

If a decision is made by the government beforehand, the guarantee of a Federal bailout might act as a disincentive to safety. Federal assistance after the fact would probably create enough uncertainty and anxiety about whether help will come, how much and under what circumstances that there would still be a safety incentive.

This alternative spreads the risk more than any other, since all U.S. taxpayers would be contributing. The cost, therefore, per taxpayer also would decrease enough that it would not hinder most people's ability to pay. In fact, more funds could probably be generated under this scheme than under any other.

Incentives for corporate responsibility by nuclear utilities would be low under these circumstances, since many individuals who have no connection with nuclear electricity would be helping to pay for an accident. This result could vary, depending upon what terms, if any, the Federal government imposed upon its assistance.

The type of Federal aid could also indicate the national policy on nuclear power. Thus, if Congress decided next year that, in the event of future accidents, it would pay for all replacement power costs, this would be a clear signal of Federal support for the nuclear option. Congressional inaction, however, would not necessarily be an indication of a lack of support of nuclear power, since Congress often has many reasons for not acting, such as trying to keep a balanced budget or a perception that the problem simply does not demand Federal attention.

There is no simple solution to this issue of who should pay for replacement power, as the above discussion illustrates. Political entities that are faced with this issue must consider the facts of the particular situation and all relevant factors in order to arrive at a decision which allows them best to serve the financial and the safety needs of their constituents.

CONCLUSIONS AND RECOMMENDATIONS

It is too early to tell what effect NEIL will have on the ability of a utility to recover from an accident. The effort NEIL represents—that of an industry attempting to become more responsible for its actions—is an admirable one that utility personnel should pursue. The benefits of NEIL could be multiplied many times over if there were a connection between NEIL and INPO (assuming INPO lives up to its goals) so that the availability of NEIL coverage would serve as a reward for those utilities achieving a high level of safety. NEIL is in a position to encourage INPO to develop standards that will be of use to NEIL, although it does not appear to be taking much initiative in this area, which is unfortunate.

Even if NEIL meets its anticipated goal of offering a total of $156 million in insurance, the coverage is still very limited, leaving utilities with enormous costs for providing replacement power and decommissioning the plant.

NRC regulations provide that applicants for an Operating License must demonstrate to the NRC that they have "reasonable assurances of obtaining the funds necessary to cover the . . . estimated costs of permanently shutting the facility down and maintaining it in a safe condition" (i.e., decommissioning the plant). (10 CFR § 50.33) The accident at Three Mile Island and its aftermath amply demonstrate a real need for the NRC to focus on this requirement.

NEIL is a beginning, but only a very small step in the long effort to ensure that nuclear utilities, and therefore the public, are able to withstand the financial effects of a major accident.

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Chapter 3

Three Mile Island: The Financial Fallout

By the

Comptroller General of the United States,
General Accounting Office

REPORT BY THE

Comptroller General

OF THE UNITED STATES

Three Mile Island: The Financial Fallout

The nuclear accident at Three Mile Island raised serious questions about the financial ability of the electric utility company owners to clean up and repair the damaged reactor facilities while continuing to provide reliable electric service to customers.

Financial insolvency of the companies is not imminent and power supplies are assured for the immediate future. However, the loss of earnings capability by the Metropolitan Edison Company makes it questionable whether it can fund its share of the clean-up costs and maintain system reliability without large rate increases or some external financial assistance.

The accident has shown that the utilities and Federal and State regulatory agencies were not prepared to deal with recovery from such a large financial loss. The Department of Energy should move swiftly to assess the financial needs of the affected utilities and develop plans for meeting them.

UNITED STATES GENERAL ACCOUNTING OFFICE

EMD-80-89
JULY 7, 1980

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-199244

The Honorable Gary Hart, Chairman
The Honorable Alan K. Simpson
  Ranking Minority Member
Subcommittee on Nuclear Regulation
Committee on Environment and
  Public Works
United States Senate

As requested in your January 18, 1980, letter, this report discusses the financial capability of the General Public Utilities Corp. and its operating companies to fund the costs of cleaning up the damaged reactor unit 2 at Three Mile Island. It also discusses the companies' capability to continue providing reliable electric power and the actions taken, or not taken, by the responsible Federal and State regulatory agencies. The report contains a recommendation regarding the need for an additional study of the issues before a final decision can be made as to the need for outside financial assistance.

At your request, we did not take the additional time required to obtain agency comments on the matters discussed in this report.

Unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the report date. At that time, we will send copies to interested parties and make copies available to others upon request.

Milton J. Socolar

Acting Comptroller General
of the United States

REPORT BY THE
COMPTROLLER GENERAL
OF THE UNITED STATES

THREE MILE ISLAND:
THE FINANCIAL FALLOUT

DIGEST

The nuclear accident at the Three Mile Island powerplant triggered a number of serious problems for the General Public Utilities Corporation, including a near financial crisis, as it moved to purchase high-cost replacement power to maintain service to its customers. During the year following the accident, the Corporation was recovering only a small part of the $233 million of power costs from utility rates.

Important financial questions were raised by the accident.

--Can the utilities afford the estimated $500-600 million needed to decontaminate and repair the damaged nuclear reactor and related facilities while continuing to fund an additional $2 to 3 billion in capital expenditures to insure reliable electric service to their customers?

--What are the financial alternatives for meeting the large costs?

--Have Federal and State regulatory agencies effectively dealt with the situation?

These are questions that could affect the future of nuclear power generation as well as Three Mile Island.

In the case of Three Mile Island, GAO studied these questions and concluded that:

--Adequate supplies of replacement power are currently available but reliability of future service may be questionable if too much reliance is placed on power purchases instead of system generations.

--The Companies' cash flow problems caused by funding power purchases have been alleviated for the present by rate increases.

- --The reduced earnings capability from closing down the Three Mile Island facility has seriously impaired Metropolitan Edison Company's ability to raise the necessary capital to finance its share of the clean-up costs and continue to maintain its power supply system.

- --The alternatives for financial recovery are few--higher rates to cover the added costs, a restoration of the companies' credit rating, or some form of external assistance.

- --Regulatory agencies have not provided the utilities with a clear sense of direction on actions to undertake in recovering from the accident and planning for future needs.

POWER SUPPLIES UNAFFECTED BUT FUTURE RELIABILITY QUESTIONABLE

The General Public Utilities Corporation membership in the Pennsylvania-New Jersey-Maryland power pool and its extensive interconnections with other utility systems has allowed it to buy power to replace that lost from the Three Mile Island reactors. Present estimates of the power pool's reserve capacity above expected needs indicate that replacement power will be available to the General Public Utilities system for the next decade. However, these are the best estimates of member utilities and it is possible that unforeseen events could quickly reduce this reserve below an acceptable level. (See pp. 9, 10, and 16.)

Additional power has been available from utilities outside the power pool, but only about 400 megawatts have been on firm contract. An additional 1000 megawatts have been purchased on an as-available basis with no guarantee of delivery when needed. (See p. 10.)

Before the accident the operating companies planned to complete construction of three additional generating plants by 1990. Financial problems from the accident now make it uncertain whether they will be built as scheduled. A further complication is a costly conservation and load management program which is expected to reduce the need for additional capacity by nearly one-half but which may not be as effective as anticipated. (See pp. 9, 10, 48, and 49.)

HIGH COST OF PURCHASED POWER HURT COMPANIES' CASH FLOW AND RAISED RATES

The higher cost of replacement power was not initially included in customers' utility rates and the companies had to find outside funding. A Revolving Credit Agreement arranged with 45 banks provided up to $292 million to meet current expenses. (See pp. 19, 26, 30, and 40.)

The companies' ability to obtain power from the power pool immediately after the accident insured reliable service. However, this power was largely oil generated and costly. As soon as possible, the companies arranged to purchase coal-generated power from outside the power pool, reducing costs by nearly $45 million in 1979. Even with this savings, the companies' net purchases and power pool interchange more than doubled the amount for 1978. Replacement power costs for 1980 are expected to be about $325 million and to continue at that level until the nuclear units are returned to service. (See pp. 7, 18 and 19.)

Customer rate increases were finally approved by State regulatory agencies in June 1979. The increases were not sufficient to recover the Companies' actual costs which made it difficult for the companies to obtain enough cash to pay current expenses. If present estimates for purchased power are reasonably accurate, and no further rate increases are granted, the companies will pay out about $192 million more than they will collect by the end of 1980. This makes short-term bank credit imperative. (See pp. 31, 32, 33, and 45.)

Customer rates generally did not increase appreciably until the May 1980, rate increase ordered by the Pennsylvania and New Jersey regulatory agencies. The Jersey Central Power and Light Co. increased rates more than did the Pennsylvania Electric Co. and Metropolitan Edison Co. primarily because of $200 million in increases granted the company for costs not caused by the Three Mile Island accident. As of April 1, 1980, Jersey Central Power and Light Co. rates were fourth highest among 13 major Pennsylvania, New Jersey, and New York utility companies. The other two companies currently charge rates well below charges by other utilities. (See pp. 21 and 30.)

REDUCED EARNINGS WILL LIKELY AFFECT COMPANIES' ABILITY TO PAY CLEAN-UP COSTS AND MAINTAIN RELIABILITY

The State regulatory agencies' decisions to remove the costs associated with the Three Mile Island units from the companies' rate bases have reduced the earnings capability of Jersey Central Power and Light Co. and Metropolitan Edison Co. to the point where they have minimal access to capital markets. This leaves them in a relatively poor financial position with respect to paying their share of the clean-up and recommissioning costs for unit 2 and making needed repairs and additions to their transmission and distribution systems. (See pp. 28, 29 and 39.)

Except for some flexibility in their short-term borrowing arrangements, Jersey Central Power and Light Co. and Metropolitan Edison Co. depend on rate revenues to meet current and future costs. Neither company can meet the legal requirements for interest coverage and therefore, are excluded from selling long-term bonds and preferred stock. Their bond and stock ratings have dropped to an unacceptable level making it difficult, if not impossible for them to sell securities in the market even if the legal requirements were met. (See p. 29.)

Metropolitan Edison Co. is not earning enough on its non-Three Mile Island utility property to pay the fixed costs of the two nuclear units. If earnings do not increase substantially in the near future, it is questionable whether the company will be able to obtain the necessary funds to pay its share of unit 2 costs and maintain its present electric power system. (See p. 48.)

Although Jersey Central Power and Light Co. has not been affected as severely as Metropolitan Edison Co., unrecoverable interest costs on the Forked River nuclear plant, the costs of other construction to better meet load requirements, and the clean-up costs and funds for transmission and distribution construction will place an increasingly heavy burden on its finances. (See pp. 30, 46, and 48.)

NO CLEAR DIRECTION PROVIDED BY FEDERAL AND STATE REGULATIONS

Regulatory controls over the utility companies' activities are fragmented among three major Federal and two State agencies. In determining the proper course to take in planning for clean-up of the nuclear site, their additional capacity requirements, and methods of financing, the utilities have received little guidance on future regulatory requirements or assistance. (See pp. 2-4, and 34-39.)

State regulatory agencies have the major responsibility for providing a level of rates adequate to insure the financial viability of utility companies. Since January 1979, the State agencies have granted rate increases amounting to over $680 million to be collected by the end of June 1981. At the time of their last rate orders issued in May 1980, the Pennsylvania and New Jersey regulatory agencies both accepted the responsibility for maintaining the viability of the three companies. They did not, however, provide assurances that all future costs would be recoverable through rates. In fact, they urged the Federal government to provide some assistance and lessen the burden from the accident on the utilities' customers. This position leaves the utilities uncertain as to what future costs will be recoverable through rates. (See pp. 31-37.)

Although the Department of Energy has the responsibility for bulk electric power supply reliability, it has done little more than monitor the availability of power supplies. The Federal Energy Regulatory Commission regulates wholesale power rates. It has ruled on two wholesale rate filings but skirted the issue of how the accident should be considered for rate purposes. Most of the Federal involvement has been by the Nuclear Regulatory Commission in setting restart requirements for unit 1 and monitoring clean-up activities by the companies at Unit 2. The lengthy public hearing it has required before making its restart decision is a different procedure from that set for other Babcock and Wilcox reactor owners, as are a number of changes required to improve the operational safety of units. Although the conditions at Three Mile Island probably justified the different treatment, the lack of well defined criteria for meeting the requirements has been a factor in delaying the completion of the pre-start hearings. The lack of direction by DOE on capacity needs and scant guidance by the Nuclear Regulatory Commission have added further uncertainties to determining the future course of the General Public Utilities Corporation.

RECOMMENDATION TO THE SECRETARY OF ENERGY

The Secretary of Energy should undertake a detailed study of the General Public Utilities system regarding its future role as a provider of electric power, the financial considerations involved in ensuring the system can fill such a role, the ways in which finances best can be obtained, and the relationships of the various State and Federal regulatory agencies with respect to the system's current problems. The Chairman, Nuclear Regulatory Commission and the Chairman, Federal Energy Regulatory Commission should cooperate and contribute to this study to the fullest extent possible. Given the wide range of studies either completed or underway on a number of issues to be considered by the study, GAO believes the report should be presented to the Congress no later than February 1, 1981, including a statement of any specific actions to be taken by the utilities or any of the Federal agencies and any recommendations to the Congress. (See p. 61 for detailed questions the Secretary should consider in making this study.

RECOMMENDATION TO THE CHAIRMAN, NUCLEAR REGULATORY COMMISSION

Given the significant effects on the financial viability of the utilities and on consumer rates in their service areas, GAO also recommends that the Nuclear Regulatory Commission move as quickly as possible, while taking all necessary steps to protect the public health and safety, to consider and act on the question of restarting Three Mile Island unit 1. In addition, GAO recommends that the Chairman cooperate fully with the Secretary of Energy in the study of the General Public Utilities system and its needs and provide all possible assistance in fully developing the regulatory responsibilities of the Commission as they relate to the restart, clean-up, and recommissioning of the nuclear units.

ABBREVIATIONS

ASLB	Atomic Safety Licensing Board
B&W	Babcock and Wilcox
DCF	Discounted Cash Flow
DOE	Department of Energy
ERA	Economic Regulatory Administration
FERC	Federal Energy Regulatory Commission
GAO	General Accounting Office
GPU	General Public Utilities Corporation
JC	(See Jersey Central)
Jersey Central	Jersey Central Power and Light Company
Kwh	Kilowatt hour
LEAC	Levelized Energy Adjustment Clause
MAAC	Mid-Atlantic Area Council
ME	(See Met Ed)
Met Ed	Metropolitan Edison Company
MW	Megawatt
NJBPU	New Jersey Board of Public Utilities
NRC	Nuclear Regulatory Commission
O&M	Operation and Maintenance
PaPUC	Pennsylvania Public Utility Commission
Penelec	Pennsylvania Electric Company
PJM	Pennsylvania-New Jersey-Maryland
PN	(See Penelec)
RCA	Revolving Credit Agreement
SEC	Securities and Exchange Commission
TMI	Three Mile Island

CHAPTER 1

INTRODUCTION

In a January 18, 1980, letter, the Chairman and the ranking minority member of the Subcommittee on Nuclear Regulation, Senate Committee on Environment and Public Works, requested that we examine certain aspects of the financial and operating status of the General Public Utilities Corporation (GPU) and its operating companies following the accident at the Three Mile Island (TMI) nuclear plant. We were asked to assess the (1) continued reliability of electric service to utility customers, (2) increased costs resulting from the accident, (3) impact of the accident and its aftermath on the GPU companies' ability to meet their financial obligations and (4) actions taken by the major regulatory agencies with direct responsibility and/or oversight for GPU.

OVERVIEW OF GPU

GPU is an electric utility holding company registered under the Public Utility Holding Company Act of 1935. GPU does not directly provide any utility services, but owns all the outstanding common stock of the operating companies: Jersey Central Power and Light Company (Jersey Central) in New Jersey, and the Metropolitan Edison Company (Met Ed) and the Pennsylvania Electric Company (Penelec) in Pennsylvania. GPU's current investment in the common stocks of the three companies is approximately $1.4 billion.

The three companies provide electricity to about 4 million people living in about half the land area of New Jersey and Pennsylvania. In 1979, they distributed over 32 billion kilowatt hours of electric power to over 1.5 million customers. GPU also owns all the stock of the GPU Service Corporation, which serves the needs of the GPU System. The Service Corporation provides services such as administrative, financial, and engineering help to the operating companies on a cost-reimbursable basis.

GPU issues its own common stock to the public on which it pays dividends from its earnings on the common stock of the operating companies. The operating company dividends represent virtually all of GPU's earnings. GPU provides funds to the operating companies by making capital contributions; i.e., additional equity investments. The operating companies also obtain capital funds by issuing long-term debt securities and preferred stock.

The GPU System has total assets of about $5 billion, making it the Nation's 14th-largest investor-owned electric utility. In 1978, the companies completed their third nuclear reactor unit and generated 34 percent of their power from these units. Most of the remaining generation came from coal-fired plants. According to GPU officials, the reduced fuel costs from operating nuclear units, instead of oil or coal-fired units, have saved GPU System customers nearly $1 billion since the first nuclear reactor at Oyster Creek in New Jersey went commercial in December 1969.

On March 28, 1979, an accident occurred in the then recently activated unit 2 at the System's TMI nuclear facility. The accident precipitated a series of events that resulted in damage to the reactor and radioactive contamination to components that was estimated to cost between $420-450 million to clean up and repair.[1] In addition, unit 1, which was ready to restart the day of the accident after being shut down for refueling, was ordered to remain shut down until the Nuclear Regulatory Commission (NRC) could certify that mandated changes had been properly completed and the unit was safe to operate.

SEVERAL AGENCIES HAVE REGULATORY RESPONSIBILITY FOR GPU

Three Federal agencies and the Pennsylvania and New Jersey public utility commissions exercise jurisdiction over various segments of GPU System activities. Their regulatory control became increasingly evident as the companies were required to delay putting TMI-1 back in service and were not allowed to immediately pass on the higher costs of power purchases necessitated by the loss of TMI-1 and 2 nuclear units.

The Nuclear Regulatory Commission

The Nuclear Regulatory Commission is responsible for licensing and regulating GPU's nuclear units, including TMI-1 and 2, under the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, as amended. This responsibility includes providing reasonable assurance that the use of nuclear reactors does not result in undue risks to the health and safety of the public.

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[1] Estimates as of June 12, 1980, indicate costs will be substantially higher.

The Department of Energy

The Department of Energy (DOE), in consultation with the Federal Energy Regulatory Commission (FERC), has the responsibility for assuring the reliability of electric bulk power supply throughout the United States. The basic authority for Federal regulation of electric utility companies comes from the Federal Power Act of 1935. The DOE Organization Act of 1977 (P.L. 95-91) divided the responsibilities held by the Federal Power Commission until September 30, 1977 between the Secretary of Energy and FERC. The Secretary may in turn delegate certain of these powers to FERC or the Economic Regulatory Administration (ERA). ERA has been delegated responsibility for assuring the adequacy of bulk power supply and monitoring State regulatory bodies' reviews of various rate structures and standards. FERC has jurisdiction over the interstate transmission and approval of wholesale for resale rates of electricity. It also has jurisdiction over facility agreements, interstate transmission rates, and capacity and energy sales between companies and between power pools.

In addition to these responsibilities and authorities, the Department was given additional authority in the electric power area by the Public Utilities Regulatory Policies Act (P.L. 95-617). ERA was given authority to provide assistance on regulatory reform and support FERC on ratemaking and cost of service matters, intervene in regulatory cases at both State and Federal levels on national energy policy issues, and perform studies relating to power supplies and reliability.

The Securities and Exchange Commission

The Securities and Exchange Commission (SEC) administers the Public Utility Holding Company Act of 1935 (15 U.S.C. 79, et seq.). The purpose of the Holding Company Act is to protect the public, investors, and consumers from abuses associated with the control of electric utility companies by use of the holding company device. It is in part a specialized antitrust statute with the objective of reorganizing and constraining the operations of utility holding companies, and in part a regulatory statute providing for continued surveillance of the corporate structure, financial transactions, and operational practices of public utility holding company systems.

State public utility commissions

The Pennsylvania Public Utility Commission (PaPUC) and the New Jersey Board of Public Utilities (NJBPU) have key roles in determining the future financial viability of the GPU operating companies. Through the ratemaking process, State regulators may review a utility's expenses, set the amount of revenues the utility will be able to collect, and determine the appropriate rate of return it can earn on its investments. Through these mechanisms, the regulators determine the amount of profit a company can reasonably be expected to make.

OUR OTHER RELATED WORK

We responded to several requests that we examine various facets of nuclear regulation and the TMI accident. Our report, "Placing Resident Inspectors at Nuclear Powerplant Sites: Is it Working?" (EMD-80-28, Nov. 15, 1979), discussed changes that are being made in NRC's resident inspection plan to improve nuclear reactor safety. A letter report (EMD-80-76, May 27, 1980) addresses the question "Do Nuclear Regulatory Commission plans adequately address regulatory deficiencies highlighted by the Three Mile Island accident?" We are currently completing work on two other assignments. On one assignment we monitored the investigations being made of the TMI accident by the various groups and commissions to identify any issues not covered and recommend actions needed to adequately address such issues. On the other assignment, we reviewed certain aspects of the Price-Anderson Act 1/ such as the adequacy of coverage, the appropriateness of particular provisions in the act relating to third-party liability, and the need for changes. Final reports on these ongoing assignments are scheduled for release soon.

SCOPE AND METHODOLOGY OF REVIEW

The Subcommittee concerns centered around the financial impact of the TMI accident on the GPU System and its ability to fund the clean-up costs, recommission TMI-2, and provide

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1/The Act was passed by Congress in 1957 and is in section 170 of the Atomic Energy Act of 1954. It provides for insurance coverage of up to $560 million for off-site personal and property damage claims resulting from a nuclear accident.

reliable service to customers without Federal funding or placing an undue burden on consumers. Therefore, we generally limited our financial analysis to actual data for 1978 and 1979 and projected data for the period 1980-84. In some instances, we used financial data extending back to 1970 for trend analysis purposes. Data used to assess reliability of service was generally projected through 1989.

Although each of the three operating companies functions as an independent utility, much of the administration, technical support, and documentation for their operations are maintained at the GPU Service Corporation headquarters at Parsippany, New Jersey. Consequently, almost all of our work with the companies was done at that location. We held numerous meetings with corporation officials and obtained and analyzed documents, reports, studies, rate filings, generating and load forecasts, and related data. In conjunction with the GPU staff, we developed the revenue requirements that would be needed to maintain a financially viable corporation under several different scenarios of generating capacity.

We also visited the TMI plant site and discusssed clean-up and restart problems with responsible GPU and Met Ed officials. We held discussions on power availability, purchases, and reserve margins for the next decade with the Pennsylvania-New Jersey-Maryland (PJM) power pool manager and ERA officials.

We obtained and analyzed reports and documents submitted by GPU and the operating companies to SEC regarding their financial status, and assessments made by the SEC staff. We also examined documents at FERC and the State commissions relating to rate filings and commission decisions and orders.

NRC's role and responsibilities in assessing the necessary changes required at TMI-1 to improve its operational safety were discussed with cognizant NRC officials. We also discussed with NRC officials the work being done by them as part of the restart proceedings to assess the financial ability of Met Ed to operate TMI-1.

Although we had to rely on GPU officials to provide estimated future financial data for scenarios, we used the services of two consultants to independently assess the validity of financial projections made by the corporation. The methodology used on one of our assessments--the rate of return on common equity--is discussed in detail in

Appendix III. We also used the corporate accounting, tax, and bankruptcy expertise of one of the consultants to assist us in our assessment of the strengths and weaknesses of the GPU System.

We did not assess (1) the validity of the estimated $420-450 million in clean-up recommissioning costs prepared by the Bechtel Corporation, (2) the probability that GPU will recover the full $300 million in insurance proceeds on TMI-2, or (3) the likelihood that GPU will recover any damages in its claim against the nuclear unit's manufacturer.

CHAPTER 2

GPU COMPANIES CONTINUE TO PROVIDE ELECTRIC POWER BUT COSTS ARE HIGHER

The loss of approximately 1,700 megawatts (MW) of nuclear-produced electric power from TMI-1 and 2 has left the GPU system with insufficient capacity to meet the basic needs of its customers. Interchange power from the PJM power pool and power purchases from utilities outside the PJM area, however, have thus far provided the GPU companies with sufficient power to meet all customer requirements. Reliable electric service may deteriorate in the future, however, if TMI-1 and 2 are not returned to service or if other generating capacity is not constructed.

The extensive reliance on interchange and purchased power has been costly to both the customer and to the utility companies. The incremental costs of replacement power for the two TMI units were about $295 million during the period April 1979-March 1980. Approximately $97 million of these costs had been charged to customers, with the balance of $198 million deferred for later recovery. Interest costs on the money in the deferred account currently amount to about $3.4 million per month, which traditionally has not been recoverable through customer rates.

AVAILABILITY OF POWER SUPPLIES IS NOT AN IMMEDIATE PROBLEM BUT COULD BE IN THE FUTURE

The relatively favorable generating capacity position held by the GPU companies at the end of 1978 quickly gave way to energy supply deficits with the forced shutdown of TMI-2 and the delayed restart of TMI-1. The accessibility to electric power from other utility companies through GPU's interconnected transmission systems has made it possible for customers to continue receiving adequate supplies of power.

Restart delays for TMI-1 and unmet construction schedules and/or cancellations of planned generating units, however, will require more extensive reliance on outside power supplies to meet expected customer demand during the rest of the decade.

Favorable operating characteristics of the GPU System - pre-1979

The operating companies in the GPU System operate as an interconnected power pool, with all of their power demands dispatched from the GPU dispatch control center in Reading, Pennsylvania. The System's reliance on fuels other than oil for generating electricity has worked to its advantage in containing power costs following the 1973 oil embargo. The generating mix used by the System prior to 1979 consisted of 34 percent nuclear, 57 percent coal, and 9 percent oil. Ownership of the units varies, with some powerplants, such as TMI, being jointly owned by all three of the companies. Other units, such as the Oyster Creek nuclear station, are wholly owned by one company. System companies may also operate generating units in which they share ownership rights with non-GPU utility companies.

In addition to Penelec, Met Ed, and Jersey Central forming the GPU System, each company is a member of the PJM Interconnection or power pool. The purpose of PJM is to provide, through contractual agreement among the members, the service, reliability, and economy that would result if the Interconnection were one company while recognizing individual company constraints. Along with the GPU companies, Philadelphia Electric Company of Pennsylvania, Pennsylvania Power and Light Company, Baltimore Gas and Electric Company of Maryland, and the Potomac Electric Power Company (serving parts of Maryland, the District of Columbia, and Virginia) are members of PJM. Atlantic Electric, Delmarva Power Company, and United Gas & Illuminating Company are associate members.

PJM member utilities are required to provide sufficient generating capacity to meet their basic system requirements (load and reserve) or pay a penalty for undercapacity. However, they are all interconnected through an extensive transmission network and have all of their generating capacity centrally dispatched from the PJM control center in Valley Forge, Pennsylvania. Under PJM's economic dispatch concept, the lowest-operating cost units for the system as a whole are generally put on line first. For generating capacity purposes, PJM considers the three GPU operating companies as one utility.

As demand increases, the next-lowest-price unit within the system is brought into operation, regardless of which member has the demand or which member has the generating unit. The savings that result are divided evenly between the member purchasing the power and the member selling the power under a "split savings" concept.

PJM membership can further benefit utilities and their customers because their interconnections allow each company to operate with a lower reserve margin 1/ than if they operated separately. Currently the PJM system-wide reserve margin requirement is 22 percent. The projected 1980 reserve margin is approximately 28.5 percent--exclusive of TMI-1 and 2--which reflects an excess of capacity over expected system demands.

In addition to the generating facilities of its members, the PJM system is interconnected with other adjacent systems that can provide supplementary electric power in the event of (1) unusally heavy demand (2) an accident on the PJM system, or (3) the ability of adjacent systems to deliver power at less cost than the PJM system. PJM has twenty-seven interconnections with utilities external to its members' service areas. Twenty of these twenty-seven interconnection points are located within the GPU System. This situation has not only enhanced GPU's importance to PJM, but it has allowed GPU to negotiate directly with these other utility systems for power supplies without using PJM-member facilities. In addition to the interconnections, the GPU dispatch control center in Reading, Pennsylvania, serves as one of PJM's dispatch center back-up systems in the event of an emergency outage at the Valley Forge control center.

The GPU subsidiaries are also members of the Mid-Atlantic Area Council (MAAC), one of the nine regional reliability councils established after the 1965 blackout in the New England area. MAAC's basic membership is the same as PJM's plus a few rural electric companies, municipals, and small investor-owned companies operating in the general area. While PJM is concerned with the day-to-day operation of the system, MAAC's purpose is to evaluate system reliability in planning capacity needs by reviewing each company's plans to ascertain whether they meet MAAC reliability standards. This planning for future needs is important because of the length of time it takes to bring a new generating facility into operation. In some cases the time period can extend to 10 years or more from planning to commercial operation.

GPU's own plans prior to the TMI accident provided for the addition of three major generating units. The

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1/Additional generating capacity, above peakload demands, available to meet unplanned disruptions to service, usually given in percent.

largest, a 1,120 MW nuclear facility at Forked River in New Jersey, was scheduled to go into operation in 1983. Two 625-MW coal units in Pennsylvania, Seward 7 and Coho 1, were scheduled for completion by 1987 and 1989, respectively.

Current generating capacity and peak demand

As previously mentioned, PJM has set a planning reserve margin requirement of 22 percent for the total system. However, each company is given its own individual planning reserve margin requirement. The GPU System's reserve margin is 24 percent. Prior to March 1979, GPU's projection for the 1980 summer showed that the company anticipated having a system reserve of 27 percent--including TMI-1 and 2. The company projected that Penelec and Met Ed would have reserves in excess of 35 and 50 percent, respectively, and although Jersey Central would only have a 2.5-percent reserve margin, the combined GPU system reserve margin would be sufficient to meet PJM requirements.

As a result of the accident involving TMI-2, however, and the continued shutdown of the undamaged TMI-1 unit by the Nuclear Regulatory Commission, both Jersey Central and Met Ed would be extremely unreliable systems at the time of the expected 1980 summer peak demand without their outside interconnections. Penelec, however, even with the removal of the TMI-1 and 2 capacity, is projected to have a 28.4-percent reserve margin. Penelec's reserve margin theoretically enables the system to be only 11 MW short of being able to meet its 1980 summer peak. This ability to nearly meet the expected summer peak does not mean, however, that the System's own generating capacity is adequate since reliable service implies a reserve margin of about 20-25 percent above peak demand. Using GPU's reserve margin requirement of 24 percent, the System will be short about 1,468 MW of capacity at the time of the summer peakload.

The GPU System, however, should have no problem in meeting its peakload for 1980. Currently, GPU has firm contracts for 440 MW of outside power: 200 MW from Ontario Hydro in Canada, 200 MW from Pennsylvania Power and Light Company, and 40 MW from Jamestown, New York. GPU has also been purchasing over 1,000 MW of power from utilities to the west of the system on an as-available basis. In addition, the PJM Interconnection is expected to have more than enough capacity through the summer of 1980 to meet the needs of all its members--even without TMI-1 and 2. As shown in the following table, PJM projects an overall 28.5-percent peakload reserve margin, which does not include GPU's outside purchases.

PJM Projected Capability and Demand--(Summer 1980)

Reported capability	44755
Less TMI-1 and 2	1656
Remaining Capacity	43099
Pool Peak Demand	33550
Reserve Margin (28.5%)	9549

Source: Mid-Atlantic Area Council (MAAC) "Coordinated Planning Report," prepared for DOE. For purposes of this analysis the difference between MAAC and PJM is not significant.

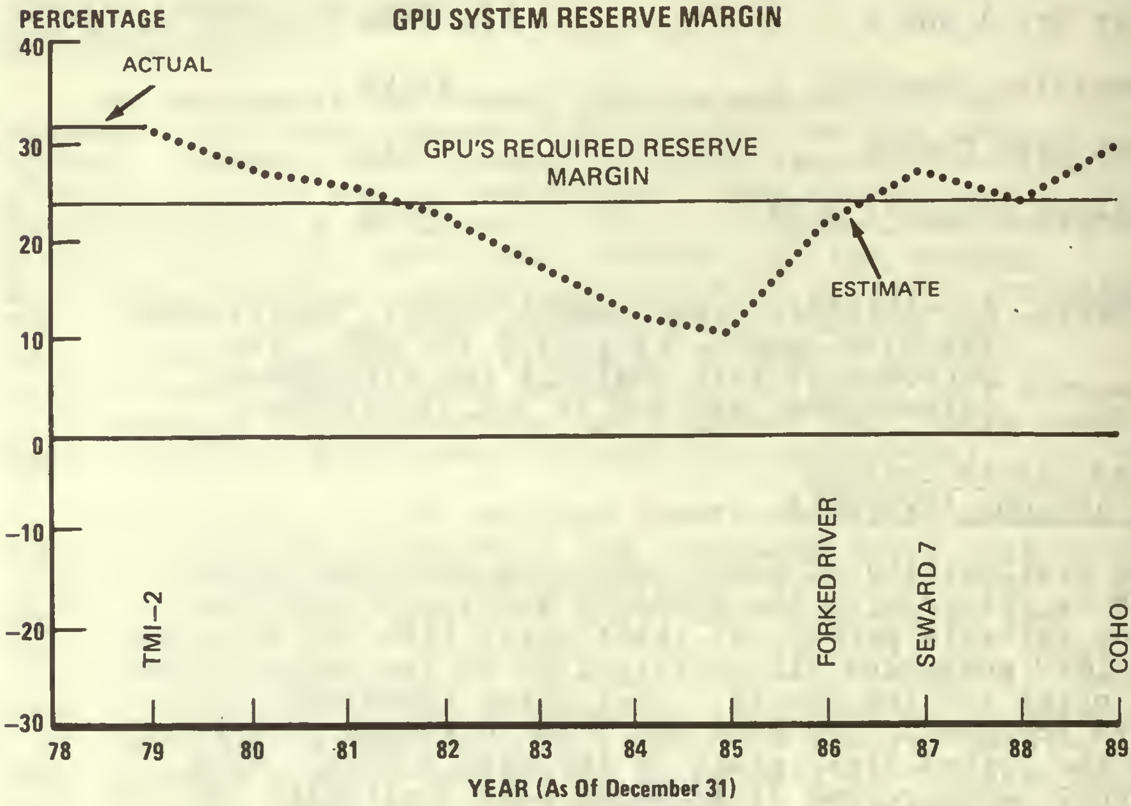
Projected System reserve margins are not favorable

The availability of power purchases and interchange with PJM is critical to the System's ability to continue providing reliable service at least until 1985 and possibly beyond. GPU suspended all construction on the Forked River nuclear plant and the Seward 7 coal plant immediately after the TMI-2 accident. GPU does not plan to resume construction on the Forked River plant in the near future. Work on Seward 7 could resume if finances were available. To provide some relief from its capacity shortage and lessen its reliance on purchased power, GPU is attempting to enter into a contract with Ontario Hydro to construct a direct current intertie under Lake Erie. Ontario Hydro would supply 1,000 MW of power to the System annually through 1991. However, completion of this transmission line and converter stations is not expected before 1985.

To understand the effect the TMI-2 accident had on the System's future generating capability, we first examined GPU's planned expansion program for the 1980s and then developed three scenarios to illustrate the effects on reserve margins of constructing or not constructing certain of the planned generating units. Our analysis of the System's actual and planned capacity and expected peakload requirements demonstrates the weak position the System is in with respect to assuring customers reliable power supplies and what is needed to restore system reliability.

Projected System reserves prior to TMI-2 accident

The following graph shows how the System had planned to meet customer demand and maintain a reliable system.



SOURCE: GPU Corporation.

In this graph and the succeeding ones, the GPU System reserve margin is shown because of the interconnected operations of the three companies through the System's central dispatch office. The line depicting GPU's required reserve margin of 24 percent reflects the PJM requirement.

Although the companies operate as an integrated system, generating capacity ownership is by individual company, and therefore each company has its own reserve margin as a measure of meeting its own load requirements. Under the planned capacity additions for the System through 1989, Penelec would maintain a reserve margin of 30 percent or more. Met Ed's margin would be 42.7 percent in 1979, but this would decline to 20 percent by 1984 and continue down until the Coho plant was completed in 1989. Jersey

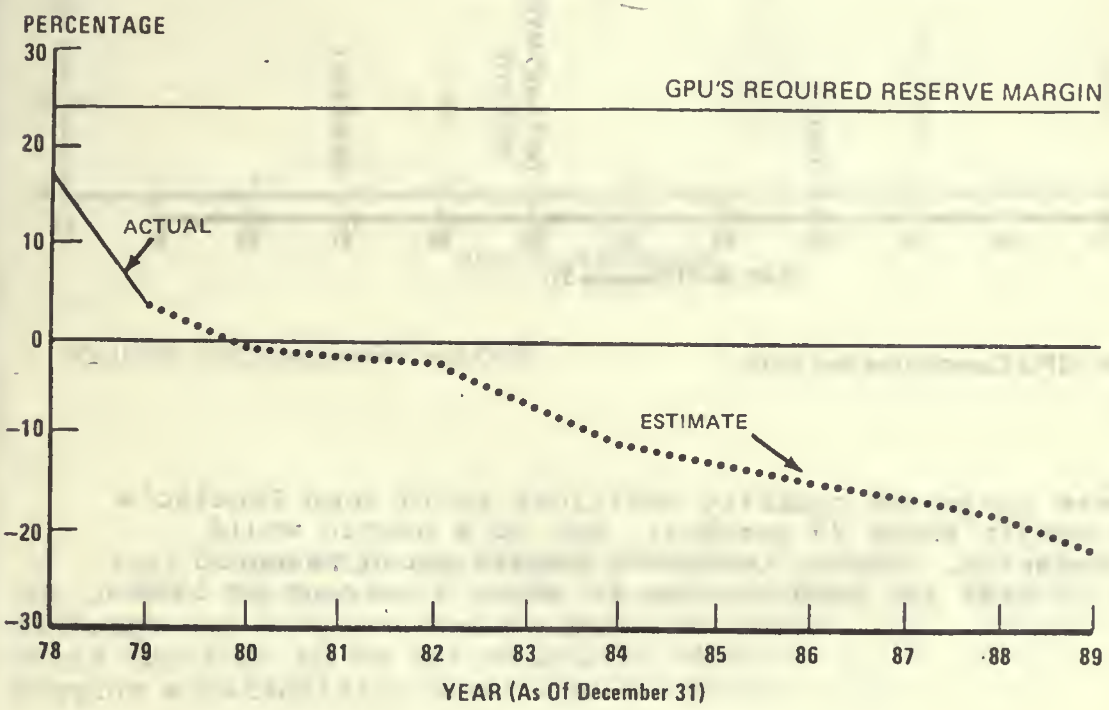
Central would remain below 20 percent even with the Forked River and Coho plants coming on line as scheduled.

Projected reserves as a result of changes required by the TMI-2 accident

The loss of TMI-1 and 2 and construction delays at Forked River and Seward 7 have added a large element of uncertainty to future System reliability. We have constructed three scenarios to assess the possible effects of this uncertainty. In each scenario, we have used currently available net generating capability of the System and its projected summer peakload for each year. According to GPU officials, peakload forecasts do not incorporate the potential effects of a strong conservation and load management program now being developed by the company. This program could reduce system demand by 1,000 MW by 1990.

Scenario 1--This scenario is the most extreme, projecting the abandonment of both TMI-1 and 2 with no new capacity added by any of the companies.

SCENARIO 1

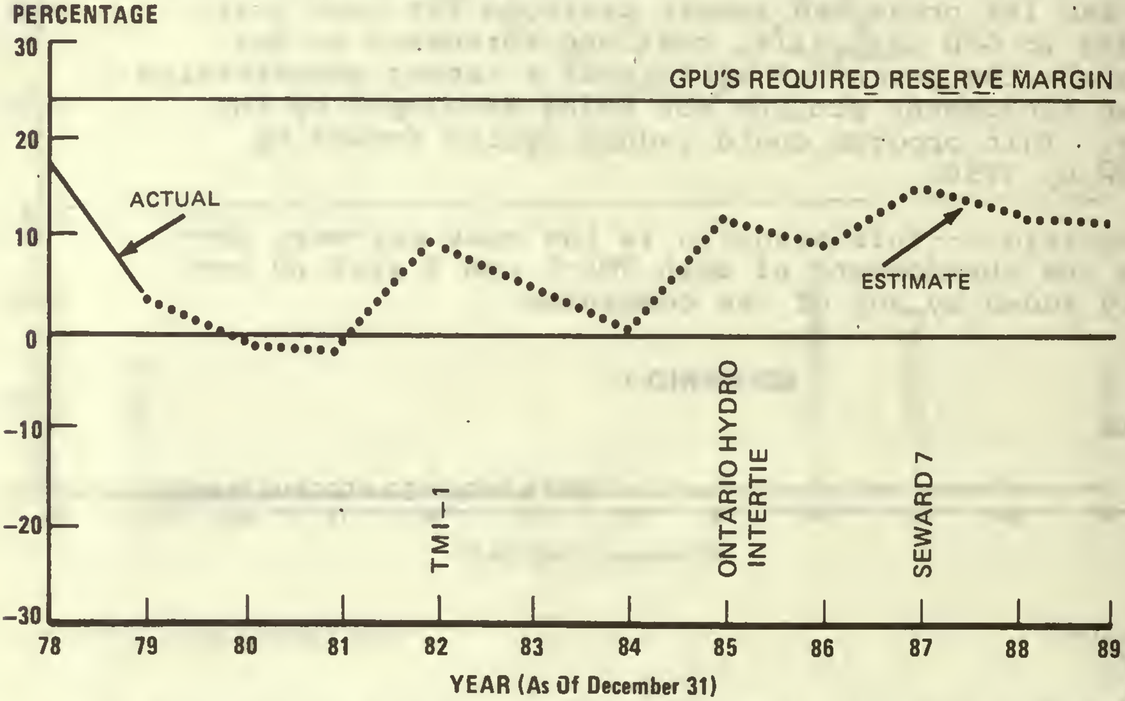


SOURCE: GPU Corporation and DOE.

Under this scenario, Penelec would be the only company with a reserve margin above zero. Met Ed and Jersey Central would essentially be distribution companies with extensive reliance on purchased power to meet customer needs.

Scenario 2--This scenario assumes that TMI-1 will return to service in 1982, the Ontario Hydro intertie will be completed by 1985, and Seward 7 will be in service by 1987.

SCENARIO 2

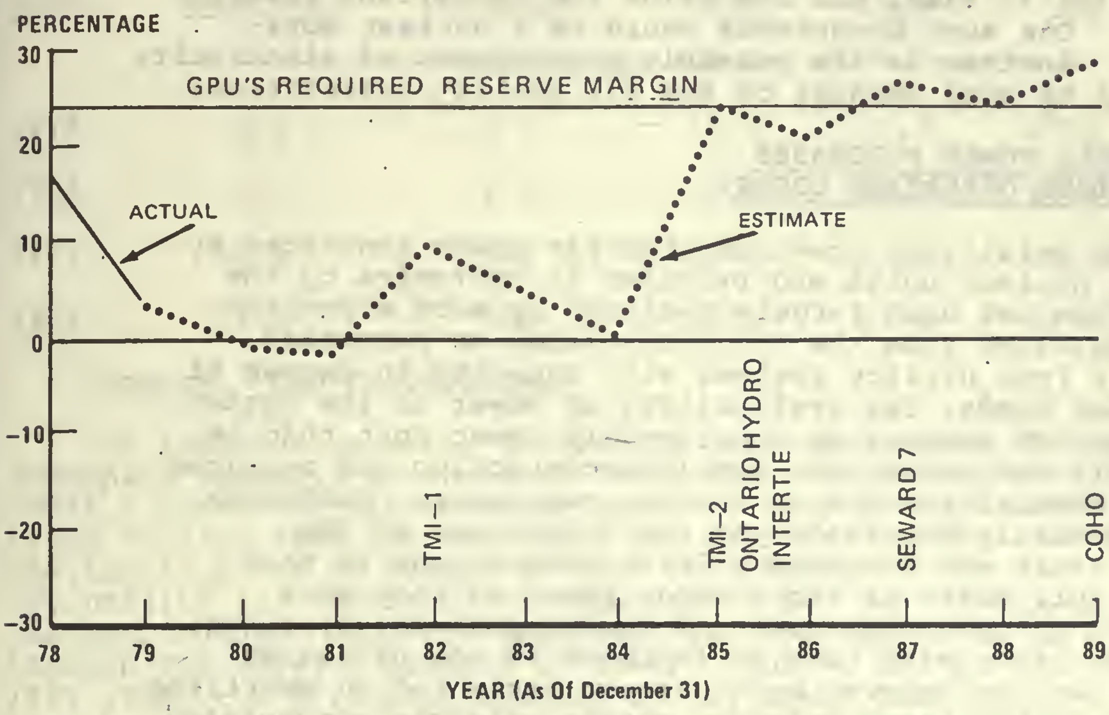


SOURCE: GPU Corporation and DOE.

These projected capacity additions would keep Penelec's reserve margin above 20 percent. Met Ed's margin would remain negative. Jersey Central's margin would reach 13 percent in 1985 and then decline to about 2 percent by 1989.

Scenario 3--This scenario more nearly reflects the System's original plan for meeting load requirements except for a 5-year delay in adding sufficient generating capacity to attain an acceptable reserve margin. We assume TMI-1 returns to service in 1982 with both TMI-2 and the Ontario Hydro intertie in service by 1985. Completion of Seward 7 is expected by 1987 and Coho by 1989.

SCENARIO 3



SOURCE: GPU Corporation and DOE.

Even under this optimistic scenario, neither Met Ed nor Jersey Central will reach a reserve margin of 20 percent although the margins will be positive after 1985. Penelec would continue to be the strongest company, with reserve margins substantially above the 20 percent level.

PJM reserve margins are expected to be sufficient to meet demand

PJM would remain a strong, viable system even if events postulated in scenario 1 happened. Under the circumstances of scenario 1, PJM would have a reserve margin of at least 25 percent until 1989, when it would slip to 24 percent--2 percentage points above the reserve margin requirements its members have set for themselves. However, it should be noted that reserve margin projections used by PJM are the best estimates of its members. It is possible that construction slippages could, at some point in time, put PJM below the 22-percent reserve margin. One such occurrence would be a nuclear moratorium. Another is the possible curtailment of electricity produced by coal because of EPA air quality restrictions.

ADDITIONAL POWER PURCHASES HAVE RAISED OPERATING COSTS

The relatively low-cost electric power generated by the TMI nuclear units and provided to customers by the GPU System has been largely replaced by more expensive power obtained from the PJM interchange or purchased directly from utility systems with capacity in excess of their own needs. The availability of power to the System from non-PJM sources at considerably lower cost than is available throughout the PJM Interconnection has resulted in substantial savings to utility customers. Customers were initially benefitted by the reluctance of the Pennsylvania and New Jersey State Commissions to pass on the full costs of replacement power as they were incurred by the companies. As power purchases continue, consumer rates will have to increase as the utilities are allowed to recover both current costs and an amortized portion of the large deferred energy balances accumulated by the companies.

Pre-accident rates reflected relatively low-cost power generation

Electric rates charged to customers are a composite of a number of costs incurred in producing a kilowatt hour (Kwh) of electricity. Operation and maintenance (O&M) costs, including fuel costs, are the largest component of total costs. To the O&M costs are added items such as taxes, depreciation expenses, interest on debt and preferred dividends, and a return on capital investments. Since fuel costs are a major item of O&M expenses, a reduction in these costs lowers rates charged to consumers. Hydroelectric plants produce the least expensive power because no fuel costs are involved in producing the electricity. Nuclear fuel, coal, gas, and oil follow in order of increasing costs. The GPU System's heavy dependence on nuclear and coal-fired generation worked to the advantage of its customers, particularly as the price of oil increased after the 1973 oil embargo. For the period 1975-1978, the GPU System generated power at the following fuel costs:

Year	Average fuel cost	Type of fuel Nuclear	Coal	Gas	Oil
	---------------	--------(mills per Kwh)	--------	--------	--------
1975	9.4	2.4	10.4	16.4	27.0
1976	9.3	2.0	10.5	16.4	26.1
1977	10.2	2.1	11.2	22.8	29.7
1978	11.2	2.3	13.2	27.6	28.6

Source: GPU Corporation.

In addition to using internally generated power, utility companies normally purchase or interchange electric power under a number of differing situations--when the purchase price is less than the utility's own production costs, when additional power is needed to meet peak demands, and when the utility has insufficient capacity of its own to supply customer needs. GPU, for example, routinely interchanged through PJM varying amounts of power. During the period 1975-1978, the following amounts of net power interchanges were reported by GPU.

Year	Total cost of interchange power ($, millions)	Cost per Kwh (mills)	Percent of total bill from interchange power
1975	$ 52.3	20.4	5.5
1976	120.8	22.0	11.5
1977	186.2	31.4	15.2
1978	133.7	31.3	10.3

The net result to consumers has been generally lower average costs than those paid by customers of neighboring utilities. As shown in the following table, Jersey Central's costs were eighth lowest out of 13 utilities and only three utilities had lower average costs than Penelec and Met Ed in 1978.

Table 2-1

Average Cost to Customers
Twelve Months Ended December 1978
(in ¢ per Kwh of sales)

Company	Cost
Consolidated Edison Co. of New York	8.14
Rockland Electric Co.	6.85
Long Island Lighting Co.	5.73
Public Service Electric & Gas Co.	5.33
Atlantic Electric Co.	4.74
Jersey Central Power & Light Co.	4.72
Duquesne Light Co.	4.53
Philadelphia Electric Co.	4.47
Pennsylvania Electric Co.	3.83
Metropolitan Edison Co.	3.80
Pennsylvania Power & Light Co.	3.53
Pennsylvania Power Co.	3.31
West Penn Power Co.	3.18

Source: GPU Corporation.

The post-accident need for purchased power increased company operating costs

The loss of generating capacity from taking TMI-1 out of service for refueling in January 1979 was offset by the entry into commercial service of TMI-2 beginning December 30, 1978. The subsequent loss of TMI-2 on March 28, 1979, however, and NRC's order to keep TMI-1 shut down even after the refueling was completed required that the operating companies increase their purchases/interchanges of power to meet customer demands for electricity. For 1979, the System's net purchases/interchanges increased to about $268 million, or more than double the amount for 1978. Of this $268 million, nearly $223 million was purchased/interchanged between April and December 1979. Fortunately, the companies were able to buy nearly two-thirds of the necessary power from systems outside PJM at considerable savings, as shown below.

Source of purchase	Total price paid	Number of Kwh purchases	Average cost per Kwh
	------(millions)	------	(cents)
PJM	$ 96.7	2,408	4.02
Outside PJM	126.2	4,259	2.96
Combined	222.9	6,667	3.34

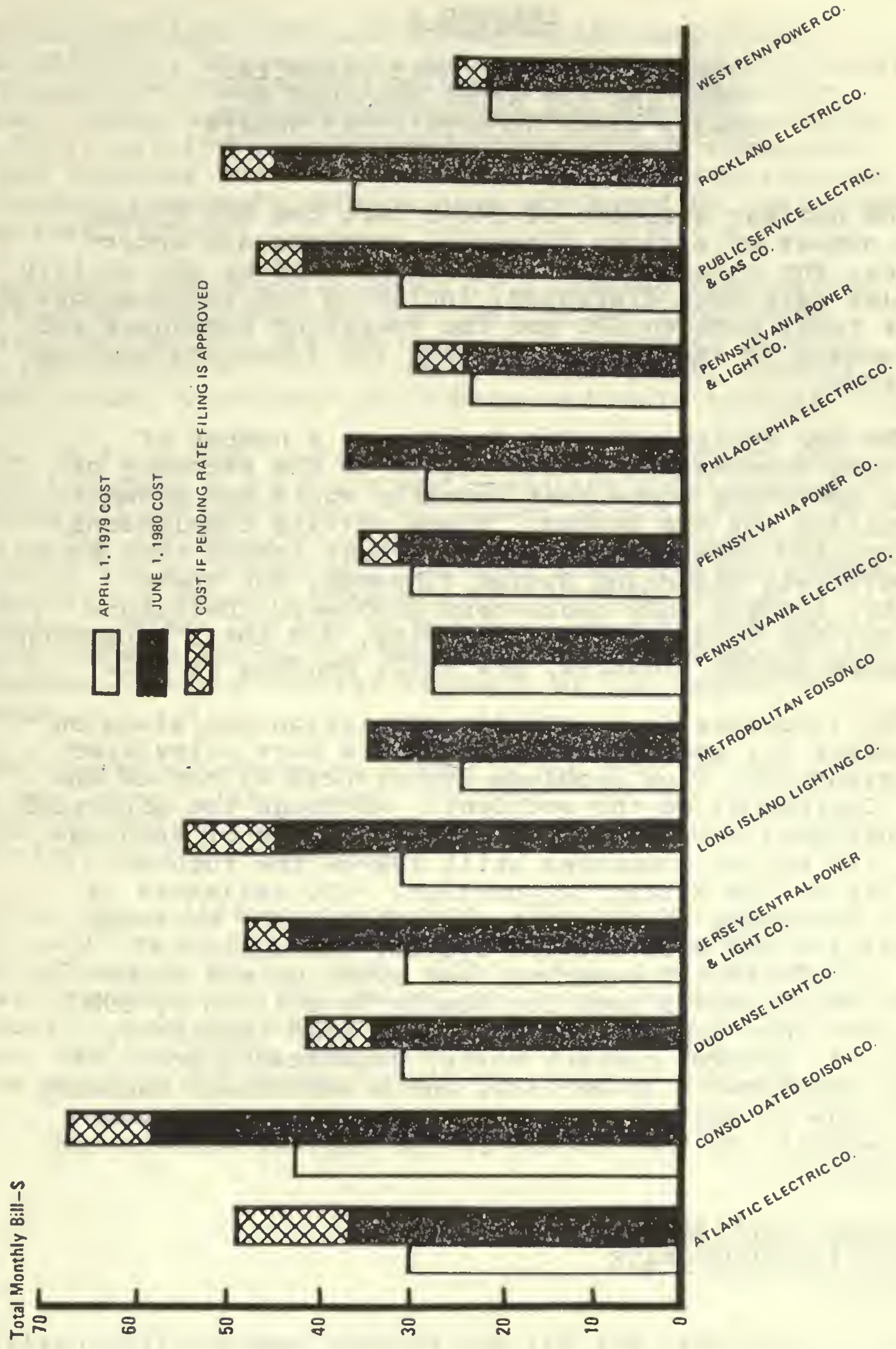
Source: GPU Corporation.

Because of purchases from non-PJM sources, this cost was nearly $45 million less than it would have been if all replacement power had been obtained from the PJM interchange under the current split savings rate schedule. Through March 1980, an additional savings of $46 million was made by increasing System purchases from outside PJM.

GPU has estimated that 1980 replacement power costs for TMI-1 and 2 will be about $325 million, or an average of $27.1 million per month. At least two factors, however, could significantly affect this cost estimate. GPU officials said that customer demand during January-March 1980 was the same as in the first quarter of 1979 and this is lower than had been anticipated when the 1980 cost estimate was prepared. If this zero growth level holds during the year, less power will be needed for the System and purchases could be reduced below the estimate for the year. In addition, there are indications that the current recession is affecting consumer demand in utility service areas to the west of the GPU System. As a result, more power from less expensive coal-fired generation may be available than was anticipated, and this in turn should reduce purchased power costs.

Despite the fact that the GPU System has had to purchase/interchange substantial power to replace the loss of the TMI-1 and 2 generating capacity, the cost of electricity to its customers has remained in the range of other utilities in the region. This is true primarily because the companies have not been allowed to pass on to their customers immediately the full amount of the higher-cost power. The rate increases granted by the State regulatory agencies prior to April 1, 1980, have largely reflected energy clause adjustments that were not TMI-related or were offset by the removal of TMI-2 from the rate base. For example, the New Jersey Board of Public Utilities granted Jersey Central $234 million in rate increases during the year following the accident. Only 34 percent of the total rate increase was TMI-related. The following chart compares, for April 1, 1979 and June 1, 1980, typical electric bills for a residential customer purchasing 500 Kwh of electricity per month from various neighboring electric utilities. It also shows, as of June 1, 1980, the rate increases filed by electric utilities and what the new rates would be if the increases are approved. Although Jersey Central rates are on the high side, rates for Met Ed and Penelec are still favorable when compared to those of most other companies.

TYPICAL ELECTRIC BILL COMPARISONS RESIDENTIAL—NO WATER HEATING—500 KWH/MONTH



SOURCE: GPU Corporation.

CHAPTER 3

SOME ACCIDENT-RELATED FINANCIAL PROBLEMS ARE BEING RESOLVED BUT LONGER RANGE UNCERTAINTIES REMAIN

The nuclear accident at TMI-2 left the GPU System with a number of serious financial problems and uncertainties. The normal financing methods used by the utility companies have been disrupted, including the intercorporate flow of funds between GPU and the operating companies and ready access to the capital markets for financing ongoing operations.

The GPU System was also faced with a number of regulatory uncertainties with regard to the recovery of certain operating costs that normally would not present difficulties for the System. State utility commissions are currently resolving some of the cost issues that have been adversely affecting System finances, but these primarily involve only short-term problems. Decisions affecting the future of the TMI units, and their impact on the future System finances, are still pending at NRC.

The favorable State utility commission decisions on rate relief for the operating companies have alleviated the serious cash flow problems experienced by Met Ed and Jersey Central since the accident. Although the potential for bankruptcy has been diminished, the loss of earnings capability by the companies still leaves the future viability of the System in question. GPU estimates of capital financing to maintain and improve the existing transmission and distribution system, add a minimal amount of additional capacity, and clean up and recommission TMI-2 show a need for nearly $4 billion by 1987. To achieve that goal, the system will need regulatory approval to recover current costs, expedited approval to restore TMI-1 and 2 to service, and a sufficient increase in earnings to restore its credibility with the investment community so that access to the capital markets can be renewed.

GPU SYSTEM ORGANIZATION PROVIDES INTERCORPORATE FINANCING

Jersey Central, Met Ed, and Penelec operate financially as three separate companies, but within the overall direction and control of GPU as the parent company. Certain specialized services that are common to all companies, such as planning, engineering, power pooling, and regulatory rate filings are provided by the GPU Service Corporation on a cost reimbursable basis. The companies are regulated by the State utility commissions as independent companies, and rates to cover the costs incurred in providing electric power to each company's service area are based on individual company rate filings.

Financing construction costs is a company responsibility. Each of the companies carries its own short-term borrowings and issues its own bonds and preferred stocks to outside investors. All of their common stock, however, is owned by GPU, with none of it being publicly traded.

The $1.4-billion investment in the common stock and consolidated surplus of its three operating subsidiaries represents all of GPU's material assets as a holding company. The dividends paid by the three companies are essentially its only income. GPU does issue its own common stock and at the present time has 61.3 million shares outstanding. Since GPU has no material assets other than operating company stock, the market price of its stock is a reflection of the financial strength of the companies as a whole.

The operating companies normally pay over 90 percent of the net income after taxes, interest, and preferred dividends to GPU in the form of dividends, leaving little of the earnings for company use.

After stock dividends are paid, GPU redistributes its net earnings to the operating companies as needed through capital contributions. Since 1970, the companies have paid dividends to GPU amounting to $1.046 billion and have received back through capital contributions $733 million. The following schedules show these dividend payments and capital contributions by company and year.

Dividends paid

Year	Jersey Central	Met Ed	Penelec	Total
	($, millions)			
1970-74	$182.5	$129.9	$151.3	$ 463.7
1975	36.7	37.8	39.7	114.2
1976	50.0	39.5	37.7	127.0
1977	63.7	49.0	37.0	149.7
1978	57.0	48.0	37.0	142.0
1979	12.0	7.0	30.0	49.0
Total	$401.9	$311.2	$332.5	$1,045.6

Capital contributions

Year	Jersey Central	Met Ed	Penelec	Total
	($, millions)			
1970-74	$179.8	$218.7	$ 89.0	$487.5
1975	13.0	-	4.14	17.14
1976	40.0	-	30.05	70.05
1977	40.0	-	45.0	85.0
1978	44.0	-	-	44.0
1979	29.5	-	-	29.5
	$346.3	$218.7	$168.19	$733.19

Source: GPU Corporation.

The large capital contributions made to Met Ed during the 1970-1974 period increased Met Ed's common equity ratio (common stock plus consolidated surplus divided by total capital) to 42 percent. In line with GPU's policy of maintaining the operating companies' common equity ratios at about 33-34 percent, all capital contributions were withheld during the 1975-1979 period. At December 31, 1979, Met Ed's common equity ratio was 36 percent.

PRE-ACCIDENT FINANCIAL CONDITION OF THE GPU SYSTEM WAS SOUND

Although the financial soundness of each of the three companies varied, the consolidated pre-accident financial position of the GPU System appeared to be favorable. An official of the SEC testified before a Senate Subcommittee 1/ and NJBPU that, prior to the TMI-2 accident, the GPU companies were soundly capitalized. During recent hearings held by PaPUC, witnesses from a management consulting firm engaged by the Commission to conduct a management audit of the GPU companies stated that "Prior to the accident, the company was prudently capitalized and its financial position was strong and improving."

Our analysis of the Corporation's financial statements for the period 1975-1977 shows that a steadily increasing earnings picture existed with commensurate increases in GPU common stock dividend payments. GPU's common stock was selling for about $20 per share in the market and the companies' bond and preferred stock ratings were reasonably good. The $742 million investment in TMI-2 was completed, and the unit was placed into commercial service on December 30, 1978. Utility commission approval to allow the TMI-2 costs in the companies' base rates was expected and this would further improve the earnings picture.

The financial picture for the individual companies was not quite as positive as the consolidated outlook. At the end of 1978, the companies were carrying about $103 million in their deferred energy accounts. This resulted primarily from State commission orders changing the State regulation of energy adjustment clauses. Rather than immediately

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1/Hearings held by Subcommittee on Nuclear Regulation, Senate Committee on Environment and Public Works, Nov. 8 and 9, 1979.

pass on to customers the full cost of these energy cost adjustments, the commissions deferred some of these costs for recovery in later periods. These amounts varied by company.

Jersey Central was probably in the least favorable financial position of the three companies. Much of the company's generating capacity relies on oil and natural gas and during the period of rising oil prices the company had been struggling to maintain a good financial position. In addition to the 25 percent investment in TMI-2, Jersey Central was constructing the Forked River nuclear plant on its own. About $350 million of its funds tied up in that project were not included in its rate base and consequently were not receiving a current cash return.

THE TMI-2 ACCIDENT AND SUBSEQUENT REGULATORY ACTIONS CHANGED COMPANIES' FINANCIAL POSTURE

The commercial phase-in of TMI-2 on December 30, 1978, offset the refueling shutdown of TMI-1 in early January 1979. This left the System's generating capacity relatively unchanged during the first quarter of 1979 but did portend increased earnings as NJBPU and PaPUC took steps to include the TMI-2 costs in the companies' base rates. The March 28, 1979 accident at TMI-2 and the continued shutdown of TMI-1, however, resulted in adverse changes not only in the System's power production capability but in its financial condition as well. These changes primarily lowered the cash flow, earnings posture, and interest coverage of the companies and were to a large extent influenced by the actions of the regulatory agencies following the accident.

Increased cash requirements posed immediate problems

The changes in the System's cash flow and short-term debt posture have come largely from the need to buy large quantities of replacement power due to the loss of the TMI units. As we discussed in chapter 2, the needed power was immediately available through the System's ties to the PJM Interconnection, and subsequent supplies were obtained from other utility companies. As was also discussed, this replacement power was obtained at a much higher cost than what had been estimated when the System rate schedules for 1979 were prepared. GPU officials stated that the basic cause for the increase is the differential between nuclear fuel costs and coal and oil fuel costs. They said for the TMI units, the fuel costs in 1979 were expected to be about 4 mills per Kwh. In contrast, coal costs equate to about 12 mills per Kwh and oil costs about 48 mills per Kwh.

Because all of the replacement power came from either coal- or oil-fired generation, the company rates chargeable to customers covered very little of the actual replacement power costs. The large quantity of power needed and the substantially higher prices paid versus System-generated power costs put a severe strain on the cash position of the companies.

Although the cost of replacement power has been the single largest cash flow effect of the accident on company finances, other unanticipated cash demands were triggered by the accident. Extensive clean-up costs at TMI-2 have already been incurred by the companies. As of April 1, 1980, about $120 million has been spent for this purpose. About $96 million of this has been recovered from insurance proceeds, but the timing of cash payments and receipts is not always the same. Safety-related changes for TMI-1 have also required cash resources which are not covered by insurance proceeds and are not recovered in current rate schedules.

An adequate cash flow is important to a utility company if it is to remain solvent. Cash flow is dependent on two external constraints--availability of bank borrowing and rate regulation--over which the utility has little influence. Unlike many businesses that can immediately reflect their production costs and a profit margin when the product is sold, electric rates are affected by a time lag--whether regulatory or mechanical--that represents a mismatching of current costs and revenues. These unrecovered costs are held in a deferral account for later recovery through customer rates. Utility payment for these incurred, but uncollected, costs are normally covered by a cushion of internally generated funds or by short-term bank borrowings. Substantial increases in unanticipated expenses, such as those resulting from the TMI accident, can quickly reduce the cushion of available funds. The only recourse then is prompt regulatory rate relief or increased bank borrowings, if available. If neither of these is available and current cash requirements exceed current cash receipts, the alternative is insolvency.

Continued earnings are important for future financial viability

Closely allied to a utility's cash flow is its earnings capability. A company needs to collect not only enough revenues to meet its current O&M expenses, interest, and tax liabilities, but also a return on its invested capital. This is a critical factor in ensuring its continued ability to provide the necessary power supplies to its customers. The GPU System, like other utilities, relies heavily on outside investors for funds to build generating powerplants and related facilities. Unless the companies have sufficient earnings to repay the borrowed funds and pay dividends to stockholders on their investment, these external sources of funds will dry up.

Investors in utility stocks and bonds assess the relative risks of owning one company's securities versus those of other similar companies. An unusual event,such as the TMI accident with its attendant uncertainties as to recovery costs and their effect on the GPU System, increases the risks for investors. This perceived increase in risk for the GPU System securities was noted immediately by the Moody's rating service and subsequently by the Standard & Poor's rating service. Table 3-1 lists the quality ratings by Moody's for the operating companies' securities as they stood on March 28, 1979, together with the changes that have occurred since then. At the time of the accident, all but one of the companies' securities had a "Baa" or better rating. A "Baa" rating represents a medium grade security which is considered to be neither highly protected nor poorly secured. A "B" rating represents a lack of desirable investment characteristics.

TABLE 3-1

Moody's Quality Ratings Of GPU Securities (note a)

	3/28/79	4/19/79	6/29/79	3/28/80
Jersey Central				
Bonds (note b)	Baa	No change	No change	Ba
Debentures	Ba	No change	No change	B
Preferred	"baa"	No change	No change	"b"
Met Ed				
Bonds (note b)	A	Suspended	Baa	B
Debentures	Baa	Suspended	Ba	B
Preferred	"a"	Suspended	"ba"	"b"
Penelec				
Bonds (note b)	A	Baa	No change	Ba
Debentures	Baa	Ba	No change	Ba
Preferred	"baa"	"ba"	No change	"b"

a/Definition of Moody's rating symbols contained in app. II.

b/Includes pollution control bonds.

Source: Moody's Public Utility Manual.

As a result of decreased earnings capability, the GPU companies have been unable to meet the legal interest coverage requirements necessary to issue bonds and preferred stocks. This situation may change with the current rate increases, but most purchasers appear unwilling to invest in a utility system whose current and future financial viability is in question. Until such time as the System's rate of return and earnings potential improves to the point where the perceived investment risk is substantially decreased, the availability of external capital financing remains an uncertainty.

Regulatory agencies' actions have affected cash flow and earnings

Actions taken by the Pennsylvania Public Utilities Commission and the New Jersey Board of Public Utilities have had the most direct impact on the present financial position of the System. To date, extensive rate relief given to Jersey Central by NJBPU has materially improved its cash flow position. Only about one-third of the approximately $300 million increase, however,is related to the TMI units. PaPUC has also responded to Met Ed's and Penelec's problems. A May 23, 1980, final decision with respect to recovering deferred energy costs will improve these companies' cash positions. The longer range earnings picture has not been helped, however, by the States' decision to take the investment and other costs of both TMI-1 and 2 out of the utilities' rate base.

The extended schedule of NRC prior to the restart of TMI-1 has exacerbated the companies' cash flow and earnings problems. FERC's rate action on the companies' filings for wholesale sales rate increases was positive, although by using the settlement procedure rather than the hearing process, some of the issues concerning rate treatment of TMI-1 and 2 were not addressed.

State utility commission actions

During the 14 months following the accident, NJBPU granted Jersey Central over $300 million in rate increases, most of it under its Levelized Energy Adjustment Clause (LEAC). 1/ Only one-third of this amount, however, was related to replacement power costs for TMI units. The remaining two-thirds was granted to Jersey Central to cover the higher costs of fuel for its own generating units and for non-TMI-related power purchases.

After initially allowing TMI-2 investment costs in the rate base by its order of January 31, 1979, NJBPU took the following actions after the accident on March 28, 1979.

1/A regulatory process used to adjust consumer rates as a result of fluctuations in fuel costs.

Jersey Central Power & Light Company

Date	NJBPU action taken	Amount allowed (rescinded) ($, millions) 1979	1980	1981
1/31/79	Increased base rates ($33.8 million annually)	$31.0	$33.8	-
6/18/79	Increased LEAC for TMI replacement power costs ($112.5 million over 18 months)	37.5	75.0	-
	Reduced base rates by removing TMI-2 costs ($29 million annually)	(14.5)	(29.0)	($14.5)
9/05/79	Increased LEAC for non-TMI related energy costs ($70 million over 12 months)	23.3	46.7	-
3/06/80	Increased LEAC for non-TMI related energy costs ($84.2 million total)	-	70.2	14.0
4/01/80	Increased TMI-related energy costs ($34.2 million total)	-	28.0	6.2
	Reduced base rates by removing TMI-1 costs ($17.9 million annualized)	-	(13.4)	(8.95)
	Increased recovery of pre-accident deferred energy costs of $51.4 million at $1.5 million/month until TMI-1 is restarted	-	13.5	9.0
5/13/80	Interim increase to base rates ($60.0 million annualized) (note a)	-	35.0	30.0
	Net rate recovery allowed--1979	$77.3		
	TMI energy cost recovery--1979	$37.5		
	Net rate rcovery allowed--1980		$259.8	
	TMI energy cost recovery--1980		$103.0	
	Rate recovery allowed through June 1981			$35.75

a/ This does not include the potential ruling on the remaining $113.5 million.

PaPUC has responded to the needs of Met Ed and Penelec in a manner similar to that of NJBPU for Jersey Central. After initially allowing the companies' investment in TMI-2 to go into rate base, the Commission rescinded its order shortly after the accident and effectively negated planned increases in rate revenues. Subsequent commission actions, as shown below, were concerned with both replacement power cost-recovery allowances and a further reduction in base rates by the removal of TMI-1.

Metropolitan Edison Company

		Amount allowed (rescinded) --------$, millions)------		
Date	PaPUC action	1979	1980	1981
6/19/79	Reduced base rates for TMI-2 cost ($3.0 million annually)	($ 1.5)	($ 3.0)	($1.5)
	Increased LEAC for replacement power costs for TMI units ($44.6 million annually)	22.3	44.6	-
	Recovery of pre-accident deferred energy charges ($3 million annually)	1.5	3.0	1.5
2/08/80	Increased LEAC for TMI replacement power costs ($55 million annually) (note a)	-	45.8	-
5/23/80	Reduce base rates by removing TMI-1 ($26.9 million annually)	-	(13.45)	(13.45)
	Increased LEAC for TMI replacement power costs $26.9 annually)	-	13.45	-
	Recover $84.6 million deferred energy cost balance as of 2/28/80 over 18 months. ($74.9 TMI-related)	-	32.9	28.2
Net rate recovery allowed—1979		$22.3		
TMI energy cost recovery—1979		$22.3		
Net rate recovery allowed—1980			$126.3	
TMI energy cost recovery—1980			$119.5	
Rate recovery allowed through June 1981				$14.75

a/ Confirmed and made final by May 23, 1980 order.

Pennsylvania Electric Company

Date	PaPUC actions taken	Amount allowed (rescinded) ($, millions)		
		1979	1980	1981
1/27/79	Increased base rate ($56.2 million annually)	$51.5	$56.2	28.1
4/25/79	Reduced base rates by removing TMI-2 ($25 million annually)	(16.7)	(25.0)	(12.5)
4/19/79	Reduced base rates by removing additional TMI-2 costs ($1.6 million annually)	(0.8)	(1.6)	(0.8)
	Increased LEAC for TMI replacement power costs ($36.1 million)	18.0	36.1	-
	Recovery of deferred energy charges ($1.6 million annually)	0.8	1.6	0.8
5/23/80	Reduced base rates by removing TMI-1 costs ($11.7 million annually)	-	(5.8)	(5.8)
	Increased LEAC for TMI replacement power costs ($21.9 million annually)	-	12.8	-
	Recovery of deferred energy cost balance ($7.8 million over 18 months)	-	3.0	2.4
	Net rate recovery allowed—1979	$52.8		
	TMI energy cost recovery—1979	$18.0		
	Net rate recovery allowed—1980		$77.3	
	TMI rate recovery allowed—1980		$48.9	
	Rate recovery allowed through June 1981			$12.2

In addition to the rate decisions rendered by PaPUC and NJBPU since the accident, each regulatory body has initiated actions that could affect the future course of the GPU System. PaPUC and NJBPU have also gone on record in their most recent rate orders that the Federal Government has a financial role to play in responding to the aftermath of the accident.

PaPUC actions--In late 1979, PaPUC selected a managment consulting firm to do a management and operations study of Met Ed/GPU as a major part of the Commission's comprehensive regulatory response to the TMI accident. The purpose of the study was to determine the extent to which the utility has contained costs, developed reasonable long- and short-range plans for continued operations, provided proper service to customers, and is properly organized and managed. On March 4, 1980, the firm provided direct testimony by a number of its staff on the partial results of its study in hearings before PaPUC concerning Met Ed and Penelec rate matters (Docket No. 1-79040308). Completion of Phase I of the study is expected by August or September 1980. Phase II would be a continuation of the study into areas identified in Phase I as agreed to by PaPUC.

In its June 15, 1979, order (Docket No. 1-79040308) concerning findings on Met Ed and Penelec rate filings, PaPUC noted that with respect to increased cost projections resulting from increased demands for electricity, the companies' witness testified "that the management has neither undertaken, nor even considered, specific actions to encourage conservation by the ratepayers." As a consequence, the Commission ordered Met Ed and Penelec to submit a series of conservation plans within 30 days relating to methods to encourage decreased consumption of electric power to reduce the companies' costs for purchasing replacement power.

PaPUC has made very plain its dissatisfaction with the way the Federal government has responded to the accident. In its May 23, 1980, rate order for Met Ed and Penelec, the Commission pointed out the "failure of the Federal government to respond to the accident at Three Mile Island with financial assistance that is commensurate with its responsibility for the development of nuclear energy." The Commission also pointed out that the Federal Government has been a keystone in the development of commercial uses of nuclear power and has insured, promoted, and exclusively regulated its development. The Commission referred to congressional acceptance of the idea that the Federal government should intervene in the event of a major nuclear incident when it enacted the Price-Anderson Act in 1957 and a further commitment to take the action deemed necessary and appropriate to protect the public from the consequences of a nuclear disaster when it extended the act in 1975. The Commission further stated its belief that "the people of Pennsylvania should not have to bear the entire burden--emotionally or financially--where that burden properly belongs to all those who have benefitted from the development of nuclear energy."

NJBPU actions--The New Jersey Board has taken several specific actions to expand its understanding of the needs of Jersey Central and protect its customers from paying unreasonable costs. In an Interim Order dated May 13, 1980, 1/ the Board stated that it is conducting two major investigations related to the accident. One investigation is an inquiry into the question of Jersey Central's potential fault in the accident, a full exploration of the underlying causes, and the role played by the respective companies. The Board has also commissioned a Strategic Options Study to determine the least cost option of supplying safe, adequate, and reliable services to Jersey Central ratepayers. Jersey Central has also been directed to seek out all possible purchase power agreements that would reduce costs to consumers and to negotiate successfully a contract for low-cost power from Ontario Hydro.

At the Federal level, the Board has appealed directly to the Federal Energy Regulatory Commission for relief from the high-cost split savings formula utilized in the pricing of PJM Interchange sales. In his comments on the May 13, 1980, order one of the Commissioners also reported that the Board has actively interceded with NRC on the TMI-1 restart on behalf of Jersey Central ratepayers. The Commission stated that the Board has repeatedly pointed out the financial burdens imposed by the continued unavailablity of TMI-1 and has urged NRC, subject to all relevant safety and health precautions, to return TMI-1 to service.

Finally, the Board has drawn up an action agenda for soliciting Federal assistance. It is the Board's position that the costs of TMI-2 should be spread over a much broader base than the New Jersey and Pennsylvania ratepayers.

1/BPU Dockets No. 804-285, 803-172, and 795-508A.

NRC regulatory actions

The decision by Met Ed officials on March 28, 1979, to delay the scheduled startup of TMI-1 was followed by NRC orders on July 2 and August 9, 1979, directing that TMI-1 remain in a shut-down condition until the resumption of operations is authorized by the Commission. The July 2 order specified that a public hearing would be scheduled prior to restart approval. The August 9, 1979, order established:

--eight actions that Met Ed has to take with respect to resolving concerns that TMI-1 can be operated without endangering the health and safety of the public,

--four longer term actions that Met Ed will be required to complete as promptly as practicable and show reasonable progress on the completion of such actions prior to restart, and

--an Atomic Safety Licensing Board (ASLB) to conduct the public hearings, approve intervention petitions,and render an initial decision to the Commission.

The order also directed ASLB to handle the hearings in an expeditious manner and give priority to consideration of those issues which are directly related to suspension of operations.

Progress on the restart issue has been very slow. In September 1979, Met Ed submitted the first phase of its final report on actions taken in response to the NRC order. As of April 23, 1980, 16 amendments have been added for NRC staff review and approval. An NRC official said the basis for the delays has been in the submission of the restart report and the NRC staff review. He said Met Ed's initial submission was incomplete but acknowledged that NRC had not told Met Ed officials what would constitute an acceptable report.

The August 9, 1979, order contained a proposed hearing schedule from date of notice to the Board decision. Adherence to this schedule would require that the Board provide a decision to the Commission by July 1980. An NRC official said the schedule was unrealistic given the number of days that are legally required for each step in the process. Consequently, on February 12, 1980, the NRC staff took a realistic look at the hearing process as of that date and proposed a revised schedule for completing the hearing. Under this schedule the initial Board decision to the Commission would be made in late January or early February 1981. According to the staff, even this time period may be optimistic.

ASLB has granted a number of extensions to date, although these have been somewhat offset by decreases in time requirements for other steps. Public hearings were expected to start in Harrisburg, Pennsylvania in mid-summer 1980. The starting date is currently scheduled for October 1980, with no definite completion date established. An NRC official said that Met Ed has probably completed 80 to 90 percent of the required items. The question of management competence, however, is still an open item and NRC has no acceptable criteria for measuring what it should be.

The NRC treatment of Met Ed's restart program is substantially different from that accorded to other utilities with similar reactor units. All Babcock and Wilcox (B&W)-designed reactors were closed down by NRC order after the TMI accident, but all except TMI-1 were allowed to restart without having made all the required changes and without the prestart public hearings. After-the-fact hearings are scheduled, however, for two of the reactors closed down by the initial NRC order. An NRC official said the Commission was not required to hold hearings and even today could rescind the order and let TMI-1 restart without a hearing. The official also said, however, that he believed public pressure would preclude such a decision by NRC.

Some of the required safety-related changes are also unique to Met Ed and not necessarily applicable to other B&W reactor operators. These involve the shared facilities problem; waste management capability; management problems in quality assurance, health physics, and operater training; and the financial ability of Met Ed to operate the plant.

GPU officials believe that NRC has set an unnecessarily extended schedule for the restart of TMI-1 and has allowed the schedule to slip without adequate reason. They also believe that the issues in the restart proceeding could, with no reduction in safety, be resolved much more swiftly.

These officials also believe that NRC has unnecessarily delayed decisions on matters related to the TMI-2 clean-up. This was particularly true of the decision to delay venting the containment building.

An NRC official stated that the release of the Krypton 85 gas from the containment building was perfectly safe and would be within every standard set by any agency. An NRC summary update on the status of TMI units 1 and 2, issued March 27, 1980, indicated that on March 12, 1980, the NRC staff issued a report to the NRC Commissioners recommending that GPU's plan for the release of the Krypton 85 gas by controlled venting through the stack be allowed to proceed. The Commission waited, however, until June 12, 1980, to authorize the venting of the containment building. In the interim, the Governor of Pennsylvania had an independent assessment made of the potential health hazards of venting the gas. The report provided to the Governor on May 15, 1980, 1/ supported the position that the release of the Krypton 85 gas posed no health hazard.

NRC has established a task force to assess the requirements for personnel and funding that it would need if it were to assume the responsibility for cleaning up the accident-related damage to TMI-2. Although NRC does not anticipate that such a condition is likely to occur, sufficient probability exists that the total costs may be too much for Met Ed to handle and that the responsibility to complete the work would be given to NRC. The task force expects to submit its report to the Commission by late July 1980.

Department of Energy

DOE has been only peripherally involved in the TMI issues. In the months following the accident, ERA's Office of Utility Systems prepared a preliminary report as a prelude to establishing a policy position on how to treat costs associated with major utility equipment outages. This was followed up on September 11, 1979, by a memorandum describing five regulatory options for allocating costs arising from such major outages. The memorandum left the final recommended course of action to a working group composed principally of ERA staff members. No final product, however, has emerged from the working group and no further work is anticipated.

ERA's utlity system staff also attempted to develop a computer model to assess the effects of the TMI outage on

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1/Union of Concerned Scientists, "Decontamination of Krypton 85 Gas from the Three Mile Island Plant," May 15, 1980.

system reliability. The model did not produce the desired results and further work on it was stopped. An ERA official said that the staff had used other means at their disposal to assure themselves that reliable power supplies could be provided by the GPU System and that therefore no further studies have been conducted. The official also said there may be some ERA staff involvement in GPU's plans to promote a major conservation program to help alleviate its generating capacity shortage.

FERC has been involved in three GPU company rate case settlements since the accident. The initial wholesale rate cases were filed by Penelec on September 1, 1978; by Met Ed on November 13, 1978; and by Jersey Central on December 18, 1978 as a means of fully reflecting in the resale rates the cost consequences associated with the commercial operation of TMI-2. The Jersey Central filing also included general cost increases which had occurred since 1976. Following the TMI-2 accident, discussions were held with the involved parties as to how the ongoing costs of TMI-2 should be equitably shared. In the Penelec case, the company suggested that one method of sharing the cost would be to include the TMI-2 investment in rate base but to reflect in its capitalization a zero return on the common equity portion of the investment in the unit. A similar proposal was made for the Jersey Central case and settlement agreements were subsequently approved by FERC. Like all dollar settlements under the Federal Power Act, these settlements do not establish any principles or precedents. The decision on Met Ed's filing is still pending before FERC.

EFFECT OF REGULATORY ACTIONS ON GPU SYSTEM FINANCES

State and Federal regulatory commission actions taken since April 1979, have materially aided the System companies in remaining solvent but have done little to provide solutions to the longer range problems of increased earnings and the restoration of full financial viability. The rate relief ordered by the State utility commissions will improve the System's cash flow and reduce the pressure on short-term bank borrowings, but the lack of dividend payments by the companies will severely limit GPU's role in providing financial assistance to the operating companies.

The decline in earnings capability resulting from removing the TMI units from base rates and the regulatory delay in returning TMI-1 to service have contributed to the System's uncertain ability to maintain reliable service and pay the clean-up and restoration costs of TMI-2.

Cash flow problems have been temporarily alleviated

On June 15, 1979, GPU officials negotiated a Revolving Credit Agreement (RCA) with 43 1/ banks to provide a maximum of $412 million of short-term borrowings for the System. These funds were to finance the unrecovered cost of purchased replacement power and other current cash obligations. The banks have thus far limited the System's borrowings to $292 million and at the present time there is no certainty that the limit will be increased. These short-term RCA borrowings allowed the System to pay for the power necessary to continue providing service to customers and avoid insolvency, but by April 1980 the RCA credit limit was rapidly being reached by Met Ed and Jersey Central. Penelec, on the other hand, had its short-term borrowings paid up.

The State commissions' rate orders granting the utilities authority to collect the current cost of purchased power and to recover expeditiously the companies' deferred energy costs are now providing a sufficient cash flow for the System to meet its current obligations and reduce its short-term bank borrowings. The tenuous position of Met Ed and Jersey Central just prior to their last rate increases, however, was expressed by both PaPUC and NJBPU. In ordering the full recovery of current energy costs, PaPUC stated that Met Ed's extreme dependence on short-term debt creates an unstable financial condition which potentially threatens the continued provision of utility service to its customers. NJBPU was more explicit in detailing the financial condition of Jersey Central prior to granting the company a $60-million interim rate increase on May 13, 1980, The Board found that:

1. Jersey Central will exhaust its short-term debt limit under its Revolving Credit Agreement before the end of May.

2. Under current rates, Jersey Central does not have sufficient interest coverage to sell long-term debt or preferred stocks.

3. GPU cannot sell common stock in its present financial condition.

4. Overall, under existing rates, Jersey Central will not be able to finance construction required to insure safe, adequate, and proper service.

1/ Two other banks were added later.

GPU's cash receipts and disbursements forecast for 1980--made prior to the latest rate increases--shows a projected cash balance of only $8 million on December 31, 1980. As shown in table 3-2, this compares to cash balances available on January 1, 1978, 1979, and 1980, of $27 million, $18 million, and $69 million, respectively. The $8-million cash balance represents only 0.4 percent of the System's total estimated revenues. The occurance of any event, or combination of events, that would cause expected revenues to decline or expenses to increase could quickly wipe out the $8 million.

Under normal operating conditions, a low year-end cash balance would not be a significant factor in a utility's financial viability. What is more important is the availability of credit. In 1978, for example, the difference between revenues (plus beginning cash balance) and disbursements, capital costs, and capital expenditures was a $127-million deficit for Jersey Central and a $151-million deficit for Met Ed. In both cases, the companies made up the cash deficit by issuing bonds and borrowing from banks.

For the GPU System in 1980, however, normal financing is not readily available and therefore the cash position becomes more critical. The present uncertainties have essentially denied the companies access to the long-term bond market. Given a continuation of high-cost purchased power and less than full recovery of current costs, the funds available through the Revolving Credit Agreement would soon be exhausted. The removal of TMI-1 and 2 from the companies' base rates has adversely affected earnings and further limited the System's options for securing needed funds.

Given the seriousness of the System's financial outlook, the May 1980, NJBPU and PaPUC rate orders providing an additional $78 million in revenues are a much-needed impetus to restoring credibility with the financial community. If the current projected revenues and expenses are close to actual, the additional $78 million would provide a cushion that would help stabilize the System's short-term cash needs and provide funds to cover expenditures not recoverable through consumer rates.

Table 3-2

GPU System Cash Receipts & Disbursements

($, millions)

	1978	1979	1980 estimate
Balance cash—beginning of period	$ 27	$ 18	$ 69
Receipts:			
Base revenues (except energy & TMI)	$ 813	$ 856	$ 898
Base revenues TMI-1	60	60	22
Base revenues TMI-2	20	27	-
Energy revenues	429	524	860
Total revenues	1,322	1,467	1,780
Disbursements:			
Operating costs			
Energy costs	395	525	837
Energy costs deferred	18	70	78
Payroll	127	133	143
Other O&M	170	188	208
Taxes/other than income	143	127	155
Income Taxes	4	(24)	-
Other Income	(4)	(8)	(6)
	853	1,011	1,415
Capital costs			
Interest	160	188	223
Preferred dividends	44	44	44
Common dividends	106	73	-
	310	305	267
Capital Expenditures			
Construction (ex. AFC)	336	267	252
TMI - recovery costs	-		
Less insurance recoveries		25	19
	336	292	271
External Financing			
Bonds	154	154	13
Bank borrowing	25	87	129
Preferred stock	-	-	-
Common stock	22	5	
Security retirements	(33)	(54)	(30)
	168	192	112
Balance cash—end of period	$ 18	$ 69	$ 8

Source: GPU Corporation.

Short-term bank balances and deferred energy costs remain high

Although the rate increases during 1979-80 have helped the companies avoid insolvency and possible bankruptcy, the short-term bank borrowings under the Revolving Credit Agreement for the May-December 1980 period are expected to increase by $6 million. The following table shows the expected balances for each company and for GPU.

Table 3-3

General Public Utilities Corporation
Actual and projected net short-term debt
May-December 1980
($, millions)

	May	December
Jersey Central	$133	$106
Met Ed	88	101
Penelec	-	14
GPU Corporation	44	50
System total	$265	$271

Source: GPU Corporation.

Actual and projected balances in the System's deferred energy accounts shows a similar trend for 1980. As shown below, the total deferred energy costs are expected to increase during 1980 although some decline is expected from the high point reached in March.

Table 3-4

General Public Utiities Corporation Deferred energy balances

($, millions)

	JC	ME	PN	Total
December 1979	$ 77	$ 83	$ 13	$173
March 1980	143	97	21	261
June 1980*	144	87	24	255
September 1980*	127	72	15	214
December 1980*	124	55	17	196

*Estimated.

Source: GPU Corporation.

Our analyses of effects of rate increases

We examined the relationship between rate increases granted to pay for replacement power costs for the TMI units during 1979-1980 and the actual/estimated costs of that power for that period. As shown in table 3-5, the System will be over $192 million short of meeting current replacement power expenses by the end of 1980 unless additional rate increases are granted between June and November 1980.

Table 3-5

Comparison of Replacement Energy Costs and Approved Rate Increases in GPU System: April 1979-December 1980

($, millions)

Company	Purchase/ interchange	Rate recovery	Net gain (loss)
Jersey Central	$224.1	$140.5	($ 83.6)
Met Ed	217.2	141.8	(75.4)
Penelec	99.9	66.9	33.0
System total	$541.2	$349.2	($192.0)

If the estimated quantity and costs of replacement power for 1980 are reasonably accurate, the companies will face a continuing drain on their internally generated cash resources, further reliance on bank borrowings, and further additions to their deferred energy accounts.

The large balances in the companies' deferred energy accounts, as noted in table 3-4, are the results of State regulatory decisions not to require customers to pay current energy costs as they were incurred by the utilities. The March 31, 1980, balance of $261 million consisted primarily of replacement power costs for the TMI units that were not allowed in the utilities' LEAC rate allowances.

Both PaPUC and NJBPU recognized the need to allow the utilities to recover these deferred costs, particularly those costs incurred prior to the TMI-2 accident. In its June 19, 1979, order PaPUC allowed Met Ed and Penelec to collect about $11 million per year of the $33.4 million in their deferred energy account on December 31, 1978. On May 23, 1980, PaPUC allowed Met Ed to amortize over an 18-month period the $84.6 million balance in its deferred energy account as of February 28, 1980. Penelec was also allowed to increase its rates to recover the $7.8-million balance in its deferred account over the same time period.

NJBPU has been slower to act than PaPUC in allowing Jersey Central to recover these past costs. In 1979, the Board was only allowing Jersey Central to recover its $51 million of deferred energy costs at a rate of

$2.3 million per year. It was not until its April 1, 1980 order taking TMI-1 costs out of Jersey Central's base rates that the Board increased the deferred energy cost recovery to $17.9 million annually. However, the Board has not yet provided for the recovery of the $87 million in deferred energy costs incurred since January 1979.

Expected future costs will affect revenue requirements

The need to recover the hundreds of millions of dollars already expended but not collected will be exacerbated by the need to raise an additional $3.5 to 4.0 billion over the next 5 to 7 years to fund essential costs of cleaning up TMI-2 and provide assured supplies of reliable power. Current estimated costs for the major projects that need to be undertaken are shown in the following table.

Table 3-6

Major Capital Expenditures
Proposed for the GPU System 1981-1986
($, millions)

Type of expenditure	Estimated cost
New power generation:	
Seward 7 coal plant	$ 700
Other	250
Modify existing generation	430
Transmission system:	
Ontario Hydro Intertie	250
Other	450
Extend distribution system	730
Nuclear fuel	400
Other (including conservation and load management programs)	140
TMI-2 clean-up and restoration (note a)	600
Total proposed expenditures	$3,950

a/Current estimate net of $300 million insurance proceeds.

Source: GPU Corporation.

Loss of TMI units from base rates have seriously affected System earnings

The State commissions' actions providing equivalent dollar energy revenues to replace the revenue lost by removing TMI-1 and 2 costs from base rates has done little more than help the companies meet current cash flow needs. The System's loss of a return on over a billion dollars of investment in the TMI units has had a serious effect on the companies' earnings capacity and their ability to attract the investment capital needed to complete the projects identified in the previous section. In addition to losing the return on invested capital, removing the TMI units from rate base precludes the companies from recovering any costs associated with servicing debt and preferred-stock, depreciation expense, and station operating and maintenance expense. This action has the effect of requiring the company to provide funds to cover these obligations from other sources. As of March 31, 1980, GPU officials stated that these costs totalled about $120 million for TMI-2. The subsequent loss of TMI-1 for rate base treatment on May 23, 1980, will add to this total because the funds to cover the fixed expenses for that unit will also have to come from other sources.

The effect of the System's reduced earnings capacity has been a matter of concern to the banks that have been providing funds under the Revolving Credit Agreement. In a May 15, 1980, letter to GPU and the operating companies following the May 9, 1980, PaPUC order, the banks recognized that while the rate actions taken by PaPUC and NJBPU have been responsive to many of GPU's needs, they believe that substantial questions remain as to the ongoing financial viability of the System. The letter stated further:

> "As the Banks have consistently maintained, actions amounting to the removal of TMI-1 from the rate base of GPU's operating companies are cause for serious concern, as are any modifications to rates which adversely affect earnings (as distinguished from revenues) and, thus, impede the capacity of the Borrowers to raise funds in the public securities markets. In this regard, while the favorable revenue impact of the PaPUC Order referred to above is acknowledged, its effects of eliminating all earnings for ME for 1980 is very unfavorable."

The loss of the TMI units from rate base has been particularly hard on Met Ed and has also affected Jersey Central's finances to some extent. As 50-percent owner of TMI-1 and 2, Met Ed has about $534 million invested in the two units. Currently, the fixed expenses for the two units approximates $53 million per year. Had the accident not occurred, Met Ed would have been allowed to collect revenues to cover these costs. When the units were removed from Met Ed's rate base, the company lost the right to recover these costs. Although Met Ed is allowed to earn a pre-tax return of approximately $49 million on about $200 million of its non-TMI property, all of these earnings are required to be applied to cover the fixed expenses of the TMI units. The net result of this situation is that GPU, as Met Ed's shareholder, earns no return on its investment and because of the $4 million deficit is losing a part of its investment.

The loss of Jersey Central's 25-percent share in the TMI units from its rate base was not quite as traumatic. The loss of earnings on its investment, however, severely affected its ability to continue paying the fixed cost on its $350-million investment in the construction of the Forked River project. The interest costs alone for the project amount to over $30 million per year, none of which are considered for current cash recovery.

GPU System has taken actions to relieve cash flow/earnings pressures

In addition to its efforts to minimize the costs of purchased power as described in chapter 2, GPU and the operating companies have taken a number of positive actions since the accident designed to reduce expenditures, conserve their available financial resources, and minimize the impact of the accident on consumers. Some of the major actions taken are described below.

Limited construction activities

GPU suspended work on two of its major construction programs--a 1,120 MW nuclear plant at Forked River, New Jersey, and a 625-MW coal-fired plant at the Seward Station near Johnstown, Pennsylvania. The System's projected construction budget for 1979 was $455 million, but this was reduced to $351 million in actual expenditures, a savings of $104 million. Capital expenditures for 1980 are now estimated to be about $271 million. Some routine maintenance work has also been delayed, principally to help alleviate current cash shortages. Some of these delays, however, such as tree trimming and other power line maintenance, are only stop-gap measures because these functions must be done to maintain reliable service.

Common stock dividends reduction

In April 1979, the GPU Board of Directors reduced the quarterly dividend on common stock from 45 cents to 25 cents and suspended the dividend reinvestment program. The Board later voted to omit the February and May 1980 dividend completely. The reduction of dividends in 1979 and the omission of dividends in 1980 has thus far enabled the System to retain about $92 million to offset the enormous cash drain imposed by the accident.

Energy conservation and load management program

Current estimates of available generating capacity and demand for the System indicate that 2,200 MW of additional power will be needed by 1990. This additional power supply can be obtained by (1) constructing additional plants, (2) purchasing from other utilities, or (3) constraining demand through conservation and load management programs. To limit any unnecessary demands on the System's financial resources and at the request of PaPUC, GPU has undertaken a program to pursue the third option in an attempt to reduce the need for added capacity by 1,000 MW. This program is expected to save the System and its customers over $1 billion during the next 10 years.

Earnings could be improved with a higher rate of return on common equity

The GPU companies are currently allowed to earn about a 13 percent return on common equity as part of their base rates to customers. This return was set by State regulators prior to the TMI accident and has generally reflected the returns allowed since 1972. The rate of return on shareholders' investments strongly influences both a utility's earnings level and the attractiveness of its securities to investors. In March 1980, GPU officials said they did not believe it was necessary to project their future financial needs on a return higher than the 13 percent currently allowed.

To assess the reasonableness of GPU's perception of the adequacy of the allowed rate of return, given the changed nature of the System's finances subsequent to the accident, we analyzed GPU's financial position to determine if a different rate of return, or cost of common equity capital, would better reflect the needs of the System in terms of attracting capital investments and ennancing System earnings. We recognized that forecasting a rate of return on common equity would involve problems beyond those normally encountered in making such a determination in a utility rate case. For that purpose, the concept of a return on equity is generally oriented to the present, or to a slightly historic period, rather than to the future. Consequently, the results of our analysis will be influenced by the deviations that occur between our assumptions and actual events that occur during the projected time period.

A full discussion of the methodology and assumptions used in our analysis is given in appendix III. Basically, GPU's future return on equity was estimated using the Discounted Cash Flow model--which equates the investors' required rate of return to the current dividend yield plus the expected future growth rate of dividends--and the following assumptions:

--Future dividend yields will equal forecasted AA utility bond yields plus a risk premium.

--Future dividend growth rate is equal to the historical average dividend growth.

--Risk premiums will decline over the 5-year forecast period.

Based on this methodology and set of assumptions, our best estimates of future returns on common equity for GPU are:

Year	Estimated GPU return on common equity (percent)
1980	19%
1981	16
1982	15
1983	14
1984	13

It is important to note that the return on equity for GPU is a function of the investment risk of GPU in its entirety rather than of any one of its operational units. The overall risk of the parent is determined by the risks of the subsidiaries and the way in which those risks interact in combination. Investors' perception of risk will be for the parent company, GPU, and will be of the net risk of all the subsidiaries acting together.

The intrinsic return on equity of GPU subsidiaries cannot be empirically estimated because they do not have publicly traded common stock. Each subsidiary may contribute more or less than the average contribution of risk to the parent, but the measurement of such risk contribution is difficult. Therefore, the return on GPU's equity is properly assigned as the return on equity for each of the operating subsidiaries.

Finally, it should be noted that the return on equity plays an important role in the financial integrity of any company. Just as the GPU System must earn a return sufficient to pay its interest on long-term debt and dividends on preferred stocks, the System must also earn a return on the common shareholder's investment, on average over a period of time, that is at least equal to its cost of equity capital. If it fails to do so over an extended period of time, it will be unable to obtain additional equity capital for either expanding or maintaining its plant and service. In the short run, shareholders may bear the penalties of an inadequate return, but in the longer run if the return is not adequate, then investors will not continue to supply additional capital.

Subsequent to our March 1980, discussion with GPU officials on the rate-of-return issue, Jersey Central filed a rate base case with NJBPU--the first System company to do so since the accident. On April 29, 1980, the company filed for a $173-million increase in its base rates to cover increases in all operating and maintenance costs other than those covered by the energy clause adjustment. The rate base filing also includes an adjustment to the company's rate of return. We noted that the company has recognized the need for a higher rate of return than it is currently earning. Jersey Central proposed to NJBPU that it be allowed to earn a rate of return on common equity of 15.5 percent. The company stated, however, that the perceived risk to investors of buying company securities would justify a rate of return of approximately 18 to 20 percent.

A higher rate of return will not substantially increase GPU's estimated revenue requirements

At our request, GPU officials prepared a proposed statement of return for Met Ed showing the revenues required to eliminate the cash flow problem for the period 1980-84. GPU assumed a 13-percent return on common equity in its computations, using a rate base that excluded Met Ed's investment in TMI-2. Using the results of our return on common equity analysis, GPU recomputed its proposed statement of revenue requirements for each of the 5 years. A comparison of the revenues required for Met Ed to meet its current obligations versus the revenues required to increase its earnings and improve its attractiveness to investors is given in table 3-7. As can be seen for 1980, a 19-percent return would require a $65-million increase in revenues over GPU's estimate, or about 15 percent more than GPU projects Met Ed will need to maintain solvency. By 1984, the difference in revenue requirements is only $37 million, or less than 5 percent more than Met Ed's projected revenue needs. The reduction in the difference between the estimated revenue requirements results because of the lower return on equity needed as perceived investment risks are reduced through timely action by State regulators.

Table 3-7

Metropolitan Edison Company

Comparison of Statement of Return Between Proposed GPU Rate of Capital Requirements and as Proposed by GAO
($, Millions)

	1980		1981		1982		1983		1984	
	Company	GAO	Company	GAO	Company	GAO	Company	GAO	Company	GAO
Total revenue	$423	$488	$539	$590	$610	$646	$698	$738	$790	$827
Expenses	350	353	449	451	513	515	610	612	796	698
Net before taxes	$ 73	$135	$ 90	$139	$ 97	$131	$ 88	$126	$ 94	$129
Additional deduction:										
Interest	59	57	57	52	59	51	56	52	56	55
Excess depreciation	38	38	38	38	39	39	42	42	40	40
Deferred energy	38	38	(21)	(21)	(19)	(19)	(20)	(20)	(20)	(20)
Other	(2)	(2)	-	-	(3)	(3)	(12)	(12)	(19)	(19)
Total	$133	$131	$ 74	$ 69	$ 76	$ 68	$ 66	$ 62	$ 57	$ 56
Taxable income	(60)	4	16	70	21	63	22	64	37	73
Income taxes	(28)	2	8	36	11	32	11	33	19	37
Investment tax credit	33	(1)	(6)	(27)	(8)	(5)	(8)	(5)	(15)	(5)
Federal income tax payable	$ 5	$ 1	$ 2	$ 9	$ 3	$ 27	$ 3	$ 28	$ 4	$ 32
Investment tax credit adjustment	(33)	1	6	27	8	5	8	5	15	5
Deferred taxes										
Energy	20	20	(11)	(11)	(9)	(9)	(9)	(9)	(10)	(10)
L D and other	10	10	17	17	15	15	16	16	17	17
Tax on interest of AFUDC	2	-	2	2	3	-	3	-	5	-
Consolidation Savings	-	-	(2)	(2)	(2)	(2)	(1)	(1)	(1)	(1)
Other	-	-	-	-	-	-	(2)	(2)	(6)	(2)
Total taxes	$ 4	$ 32	$ 14	$ 40	$ 18	$ 36	$ 18	$ 37	$ 24	$ 41
Return	$ 69	$103	$ 76	$ 99	$ 79	$ 95	$ 70	$ 89	$ 70	$ 88
Preferred dividends	$ 10	$ 10	$ 10	$ 10	$ 10	$ 10	$ 10	$ 10	$ 10	$ 10
Net	$ -	$ 36	$ 9	$ 37	$ 10	$ 34	$ 4	$ 27	$ 4	$ 23

Source: GPU Corporation.

CHAPTER 4

CONCLUSIONS AND RECOMMENDATIONS

There is little question that the nuclear accident at TMI-2 on March 28, 1979, has had a significant impact on the present and future viability of the GPU System and its customers. The loss of the TMI units 1 and 2 adversely affected System cash flows and earnings capability. Furthermore, the loss of the units from the System's generating capacity has required a greater degree of dependence on outside purchases of electric power to meet customer's demands.

The System's extensive interconnections and membership in the PJM power pool and its ability to purchase power from utility systems outside the PJM area have allowed it to meet its load requirements, but only at much higher costs than those attributable to the lost generating capacity. Although the dependence on these power purchases/interchanges has been relatively satisfactory in meeting short-term needs, the restoration of the System's own generating capability is of critical importance if the System is to continue providing adequate supplies of reliable power to its customers over an extended period of time. We believe that the ability of the System to fully recover from the accident, regain its pre-accident financial viability, and expand its generating capacity to required levels is questionable without the help of both State and Federal regulators.

In responding to the concerns of the Subcommittee about the financial viability of the GPU System and the role of regulatory agencies, we have reached the following conclusions.

The financial stability of the GPU System has been seriously affected by the results of the accident but recent State regulatory decisions have temporarily alleviated the System's cash flow problems and maintained the System's solvency.

The immediate impact on the System's financial viability was the drain on the companies' cash reserves to pay for the large quantities of high-cost power purchases necessitated by the loss of the TMI nuclear units. Penelec was affected to some extent, but Met Ed and Jersey Central were the most seriously affected--Met Ed because of its heavy reliance on the TMI units for generating capacity and Jersey Central because of an already short cash position due to its prior construction commitments to the Forked River project. In 1979, the System's purchased-power costs increased to $268 million, or more than double the $133 million spent in 1978. Nearly $233 million of the 1979 total costs were incurred during the period April-December. Replacement power cost estimates for 1980 increased this amount to $541 million by year end. For the 1979-1980 period the companies have only been allowed to recover $349 million in revenues from customers to offset the replacement power costs.

The time lag between purchased power payments and revenue receipts from customers has not only required the companies to add the uncollected power costs to an already large deferred energy cost account but required them to borrow the money to pay for the power at high interest rates. This has effectively limited the short-term borrowing resources normally available to pay other costs that are affected by the same time lag.

By early 1980, both Met Ed and Jersey Central were rapidly reaching the point of insolvency. GPU itself was in no position to provide any financial relief. Dividends from the operating companies had been reduced to only $49 million in 1979, down from an average of $133 million over the prior 4-year period. GPU paid common stock dividends of over $73 million in 1979, but needed to borrow funds under the Revolving Credit Agreement to make the payments and meet its other expenses. The precipitous drop in the market price of its common stock precluded GPU from selling any of its common stock to raise funds, leaving it with no real source of income until company dividends are eventually restored.

The May 1980, Pennsylvania and New Jersey rate increases for Met Ed and Jersey Central provide sufficient revenues for the companies to remain solvent and to keep current on their purchased power costs. The increase will also allow Met Ed to recover $84.6 million of deferred energy costs--paid for with borrowed money--over an 18-month period. However, the company's short-term debt is still expected to increase from $88 million to $101 million between May and December 1980. Unless a significant part of the deferred costs collected in 1981 are used to repay the bank loan, Met Ed will finish the year with a reduced deferred energy cost account but no resources to draw on to complete repayment of the loan.

Removal of the TMI units from the companies' rate base considerations has an adverse impact on earnings needed to assure the System's future financial viability and the continuation of reliable power supplies.

The States' regulatory decisions to take the TMI units out of the companies' rate bases effectively removed over $1 billion from their earnings potential. Met Ed, because of its 50-percent share of the TMI costs, was affected more than the other companies. In addition to the loss of return on invested capital, the continuing fixed costs of the two units--depreciation, interest on debt, preferred stock dividends, and maintenance costs--have to be paid for out of the return earned on other non-TMI plant investments. Since these fixed costs for Met Ed are currently higher than the earned return on non-TMI investments, Met Ed has no ability to accumulate internal cash funds to cover expenses not immediately recoverable through customer charges. These expenses include items such as TMI-1 modifications to meet NRC safety standards, the company's share of TMI-2 clean-up costs not immediately covered by insurance payments, and transmission and distribution construction costs necessary to maintain reliable service.

The loss of Met Ed's earnings on the TMI units leaves only two alternatives for it to cover its fixed expenses--increased short-term borrowings or increased rate revenues. A comparison between Met Ed's present bank-imposed ceiling of $105 million on its short-term borrowings and its current balance of $88 million indicates it has little flexibility in its financing program. Consequently, until one or both of the TMI units are allowed to restart and returned to rate base, Met Ed will be almost completely dependent on rate relief if it is to remain financially viable.

The TMI-2 accident has severely limited the System companies' ability to obtain funds from the capital market.

Most utility company financing consists of using short-term bank borrowings or internally generated cash funds to pay construction costs or unrecovered O&M costs, and than issuing common or preferred stocks or long-term bonds to pay off the short-term borrowings. This method requires ready access to both bank credit and the capital markets. Access to the capital markets is dependent on a company's dividend payment record, compliance with certain interest coverage requirements, and a satisfactory rating by bond rating agencies.

Immediately following the accident, the bond rating agencies downrated most of the debt securities of the operating companies. Although a low rating does not preclude a company from issuing bonds, some investment firms are precluded by their charter from investing in low-rated securities. In any event, prudent investors would require an interest return well above that earned by a higher-rated company to compensate for the perceived risk of the investment. The uncertain future liabilities of the company relating to clean-up costs and possible legal claims required GPU's independent auditors to render a qualified opinion on the 1979 financial statements. This has also precluded some institutional investors from buying operating company bonds. Furthermore, the reduced earnings lowered the interest coverage ratio below the legally required level for Met Ed and Jersey Central. As a consequence, long-term debt financing is not a viable option for the companies. GPU's ability to assist the companies has also been limited. GPU normally sells common stock to raise needed capital for its own expenses and to reinvest in the operating companies. The value of GPU common stock, however, has fallen to 25 percent of book value, making it impossible to sell its stock as a means of providing capital for these needs.

We believe that these conditions will persist until the regulatory agencies allow a sufficiently high rate of return on stockholders investment to adequately compensate them for the perceived riskiness of their investment and until the companies' earnings capabilities are increased by the return of TMI-1 and 2 to service.

The loss of earnings capability raises questions as to the System's ability to fund TMI-2 clean-up costs and needed generating capacity.

Without a quick restoration of earnings capability and a sufficiently high rate of return to attract investment capital, the System may not have sufficient funds to complete the clean-up and restoration of TMI-2. The latest estimate of the cost is in the range of $800-900 million--of which only $300 million is covered by insurance. This means that Met Ed could be required to pay as much as $300 million for its share of the costs. With a reduced earnings base, no access to bond markets, and minimal flexibility in short-term borrowings, Met Ed's prospects for raising the necessary funds are dim without extensive PaPUC rate relief. Jersey Central's share of the clean-up would be $150 million, but with the financial problems it faces in adding needed capacity, it too will need additional rate relief to meet its obligations. GPU will continue to face a heavy indebtedness, particularly if it attempts to resume dividend payments. With the current and future financial burdens on Met Ed and Jersey Central, it appears that dividend payments by the companies--except for Penelec --will be minimal in the foreseeable future. This effectively precludes any financial support to the companies from GPU in their clean-up effort.

Obtaining the $500-600 million for clean-up costs is further complicated by the fact that these costs are only a part of the funds needed by the System over the next 5 to 7 years to maintain reliable service. The uncertainties associated with the TMI units returning to service in the near future make it almost mandatory that the System move ahead with its plans to construct the Ontario Hydro intertie and build the Seward 7 coal plant and reduce its dependence on purchased power. The billion dollars needed for these two projects could conceivably come from external sources, but only with an improved financial posture. Another $2 billion is needed to maintain and improved transmission and distribution systems. This places an even greater responsibility on the regulators to improve the financial viability of the companies since an adequate transmission and distribution system is vital in meeting consumer needs regardless of the power supply source.

We believe that to deny the System the ability to obtain the funds necessary to restore TMI-2 to service and add the necessary generating, transmission, and distribution capacity to maintain reliable service will be detrimental to the System's customers in the long run. Without a return to self-sufficiency, dependence on power purchases could well increase but with a decrease in reliability. Rates chargeable to customers are also likely to continue increasing and they may well end up paying more for power in the future than if the funds necessary to allow the companies to recover financially were provided in the next few years.

Federal regulatory agencies have done little to expedite the System's recovery from the accident.

At the Federal level, NRC has had the principal role in overseeing the restart of TMI-1 and the clean-up operations on TMI-2. The Department of Energy's ERA and FERC have had oversight responsibility for assessing reliability of service and approving wholesale rate settlements.

NRC's order delaying the restart of TMI-1 until a public hearing is held has been the primary cause of the System's loss of earnings capacity and the extended need for additional increments of purchased power. Although the initial NRC order on TMI-1 directed ASLB to handle the hearings in an expeditious manner and give priority to consideration of those issues directly related to the suspension of operation, numerous extensions of time have been granted leading to delays in completing the hearing process. In addition, NRC has not given Met Ed the necessary guidance and criteria to ensure timely compliance with the order.

NRC has treated Met Ed's restart program differently from other utilities with Babcock and Wilcox reactors. We do not question their judgment in setting different requirement and procedures, given the situation at TMI. However, we believe that the uniqueness of the situation that led to the differing requirements should also engender different procedures for expediting the corrective actions needed and the return of the unit to service. Performance criteria that are lacking either for restarting TMI-1 or cleaning up TMI-2 should be expeditiously furnished and timely decisions on company compliance with the requirements should be made. While full recognition of the public's right to participate in the decision making process should be given, the hearing process should be conducted so that it is as equitable to the utilities as it is to the public.

The ERA staff continues to monitor the effects of the accident on reliability of service, but has not taken an active role in assessing the effects of the System's financial problems on future capacity needs. The projected availability of purchased power is seen as minimizing any reliability problems in the near term, with the added cost of this power being a State, not a Federal, problem. FERC has also been only peripherally involved in the aftereffects of the accident since the System's wholesale sales are only a small part of total sales. In the two rate cases settled subsequently to the accident, FERC officials elected not to hold formal hearings and consequently have not had to establish any principles or precedents on how accident related costs should be shared.

The slow reaction of the regulatory agencies to meet the most pressing needs of the GPU System and their reluctance to project a definite policy positon on what should be done to mitigate equitably the adverse consequences of the TMI accident have left an aura of uncertainty around the TMI restart and clean-up efforts that significantly affect the future of the System and its customers. Federal regulators appear to be reluctant to become too deeply involved while the State Commissions are giving strong indications that Federal support is needed.

Further examination of TMI aftermath is warranted

We believe that the nature of the accident with its potentially adverse effects on consumers, the GPU System, and the utility industry requires a different approach to regulation than has been seen heretofore. The present fragmented roles and responsibilities of the various Federal and State regulatory agencies need to be brought together into a unified approach towards resolving the problems created by the accident. We believe there is a need to combine the efforts of all the responsible agencies and examine the current and future needs of the System and its customers, how these needs can best be met, the extent and reasonableness of the System's recovery costs, and how these costs can and should be shared most equitably.

The studies currently being performed for PaPUC and NJBPU may well answer a number of questions about the future of the GPU System. We believe, however, that in conjunction with these studies a federally directed examination into the long-range needs of the System and its service area is necessary, both because of the interstate, interagency relationships that exist in nearly every issue and because of the significance of the new issues and their resolution for the future of nuclear power generation.

Because of its role as the national energy agency, we believe that DOE is the best-suited Federal entity to serve as the lead agency in undertaking the examination discussed above. The Department has important responsibilities for electric power supply and national energy policy. It is empowered to conduct investigations concerning various facets of the electric energy area.

The examination should be conducted with the full support and cooperation of the Federal Energy Regulatory Commission and the Nulcear Regulatory Commission. In conducting its examination, we expect that the Department would as a minimum, respond to the following questions.

--How reasonable are the present cost estimates for clean-up and recommissioning of TMI-2?

--What are the detailed costs of clean-up and recommissioning? How would insurance payments be affected if the unit were cleaned up and then abandoned?

--What is the probability TMI-1 will be allowed to restart? When? If delayed beyond the current scheduled dates, why? What is the effect on the System's finances if it is not allowed to restart?

--Given that the clean-up estimates are reasonable and recommissioning is feasible, what are the likely sources of financing the effort?

--What are the legal responsiblities of the operating companies if one company defaults on its share of clean-up costs?

--How valid are the System's projected needs for capital expenditures over the next 5 to 6 years? What effect will failure to complete it have on System reliabilty?

--How likely is it the System can finance its capital construction requirements and the clean-up/recommissioning costs?

--How much of the financial burden can be placed on consumers? On shareholders?

--What responsibility does the Federal Government have in providing assistance in the event of a nuclear accident such as Three Mile Island.

--What effect will the formation of GPU's nuclear operating corporation have on TMI-1 restart and TMI-2 clean-up efforts?

RECOMMENDATION TO THE SECRETARY OF ENERGY

We recommend, therefore, that the Secretary of Energy undertake a detailed study of the GPU system regarding its future role as a provider of electric power in Pennsylvania and New Jersey, and that the Chairman, FERC, and the Chairman, NRC cooperate and contribute to this study to the fullest extent possible. This study should have as its objective a report to the Congress, including a statement of any specific actions to be taken by the utilities or any of the Federal regulatory agencies and any recommendations to the Congress. We expect that if external assistance is needed, alternate sources of such assistance would be discussed. Given the current study efforts of NRC, PaPUC, and NJBPU, the detailed financial data developed by FERC in its recently concluded rate cases for the companies, and ERA's extensive knowledge of the System's generating capacity requirements and sources of alternate power supplies, we believe that the report can be completed and submitted no later than February 1, 1981.

RECOMMENDATIONS TO THE CHAIRMAN, NUCLEAR REGULATORY COMMISSION

Given the significant effects on the financial viability of the GPU System and on consumer rates in the System's service area caused by the delayed restart of TMI-1, we recommend that NRC move as quickly as possible, while taking all necessary steps to protect the public health and safety, to consider and act on the question of restarting TMI-1. In addition, we recommend that the Chairman cooperate fully with the Secretary of Energy in the study of the GPU System and its needs and provide all possible assistance in fully developing the regulatory responsibilities of the Commission as they relate to the restart, clean-up, and recommissioning of the TMI units.

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United States Senate
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS
WASHINGTON, D.C. 20510

January 18, 1980

The Honorable Elmer B. Staats
Comptroller General
General Accounting Office
Washington, D.C. 20548

Dear Mr. Staats:

As you know, the Senate Nuclear Regulation Subcommittee has been charged by the Senate with conducting a one-year examination of the nuclear reactor accident at Three Mile Island. In the course of this inquiry, one of the aspects being examined is the financial capability and responsibility of electric utilities to deal with reactor accidents.

On November 8-9, 1979, the Subcommittee held public hearings which focused to some extent on the financial capacity of the operator of Three Mile Island, the Metropolitan Edison Company (MetEd), to recover from the accident. During these hearings, three members of your staff, Clifford Gardner, Ronald Kader, and Alfred Francfort, assisted the Subcommittee in that phase of the inquiry. Several issues surfaced during those hearings which we believe require further study by the General Accounting Office.

We therefore request that the GAO provide responses in report form to the questions listed below:

1. Please provide an analysis of the financial capability of General Public Utilities Corp. (GPU), the parent of MetEd, to maintain that subsidiary and assist that company in the plant cleanup and refurbishment costs.

2. Can either GPU or its subsidiary afford the costs of cleanup, replacement power and recommissioning of Unit 2, the disabled reactor, without Federal funding and/or including these costs in the rate base?

3. To what extent should these costs be included in the rate base or be borne through Federal funding?

4. Have MetEd's power costs increased as a result of the Three Mile Island accident, and, if so, how much and why?

5. How have any increased power costs been distributed among customers and shareholders?

6. Have any State or Federal regulatory agencies taken any actions affecting the financial viability of the Three Mile Island plant owners?

7. Are regulatory and accounting treatments used by the Nuclear Regulatory Commission with respect to costs incurred to shut down nuclear plants adequate? If not, why not?

8. What are the Federal regulatory agency policies with respect to accident cleanup and recovery costs as far as who is to bear the cost - the ratepayer or the shareholder?

We understand that no government agency at present at the State or Federal level has done an in-depth evaluation of the financial issue with respect to nuclear accident cleanups. GAO's examination of this matter will be most helpful.

Since this inquiry is working under severe time constraints, it is necessary that we have your report no later than May 1, 1980. Should you have any questions concerning this matter, please contact Jay Boudreau at 224-6593.

Sincerely yours,

Simpson

Alan K. Simpson
Ranking Minority Member
Subcommittee on Nuclear Regulation

Gary Hart

Gary Hart
Chairman
Subcommittee on Nuclear Regulation

APPENDIX II

APPENDIX II

DEFINITION OF MOODY's RATING SYMBOLS

Debt		Preferred Stock	
Aaa	Best Quality; interest and principal exceptionally secure.	"aaa"	Top quality; good asset protection and least dividend impairment.
Aa	High quality; margins of protection may not be as large as in Aaa bonds	"aa"	High grade; reasonable assurance of well maintained earnings and asset protection in foreseeable future.
A	Upper medium grade; many favorable investment attributes; security principal and interest adequate but may be susceptible to impairment in future.	"a"	Upper medium grade; earnings and asset protection expected to remain adequate.
Baa	Medium grade; neither highly protected or poorly secured.	"baa"	Medium grade; protection adequate for present but may be questionable over long term.
Ba	These have speculative elements; not well safe guarded during both good and bad times.	"ba"	Speculative elements; future cannot be considered well assured; characterized by uncertainty.
B	Lack desirable investment characteristics; assurance of interest and principal payments over any long period of time may be small.	"b"	Lack desirable investment characteristics; assurance of dividend payments and maintenance of other terms over any long period of time may be small.
Caa	Poor standing; may be in default or may have danger with respect to principal or interest.	"caa"	Likely to be in arrears on dividend payments; does not rule out future dividend payments.
Ca	Speculative in a high degree; may be in default.		
C	Lowest rated bonds; extremely poor prospects of ever attaining real investment standing.		

These ratings may be modified by the addition of a plus or minus sign to show relative standing within the major rating categories.

FORECASTING GPU'S COST OF COMMON EQUITY

COST OF EQUITY CAPITAL DEFINED

The cost of equity capital is essentially the total rate of return required by investors in the common stock. That required rate of return on their investment is a function of the risk those investors perceive in that investment and of the state of the economy. Furthermore, the required rate of return on investment, and thus the cost of equity capital, depends on investors' perception of the overall risk of the company rather than any particular aspects of the company's risk position.

The cost of equity is the cost of all equity funds, whether those funds are used for cleaning up Units I and II, maintaining distribution systems which have nothing to do with TMI, or even building new nuclear plants. In other words, the costs that have been estimated at this point are for all of GPU's equity funds, without regard for the particular uses to which those funds are to be put. Of course, the current, relatively high cost of equity is a result of investors' awareness of the TMI accident and the ensuing clean-up costs, but those clean-up costs cannot be separated from other applications of funds and assigned a separate cost of capital.

GPU'S COST OF EQUITY CAPITAL APPLIES TO EACH OPERATING SUBSIDIARY

It is important to note that the cost of equity for GPU is a function of the investment risk of GPU in its entirety rather than of any one of its operational units. The overall risk of the parent is determined by the risks of the subsidiaries and the way in which those risks interact in combination. Investor's perception of risk will be for the parent company, GPU, and will be an expression of the net risk of all the subsidiaries acting together.

The intrinsic cost of equity of GPU subsidiaries cannot be empirically estimated because they do not have publicly traded common stock. Each subsidiary may contribute more or less than the average contribution of risk to the parent, but the measurement of such risk contribution is difficult. Therefore, the cost of GPU's equity is properly assigned as the cost of equity for each of the operating subsidiaries.

Finally, it should be noted that the cost of equity plays an important role in the financial integrity of any company. Just as GPU must earn a return sufficient to pay its interest and preferred dividends, it must also earn on its equity capital a rate of return, on average over a period of time, at least equal to its cost of equity capital. If it fails so do so over an extended period of time, it will be unable to obtain additional equity capital for either expanding or maintaining its plant and its service. In the short run, stockholders may bear the penalties of an inadequate return, but in the longer run, if the return is not adequate to reward investors for their perceived risk, then they will not continue to supply additional capital.

GENERAL METHODOLOGY: USING THE DISCOUNTED CASH FLOW MODEL TO DETERMINE THE COST OF COMMON EQUITY

The Discounted Cash Flow (DCF) model is the most appropriate for inferring from objective market data the cost of equity capital because: (1) it is consistent with the objectives and principles articulated in the HOPE (230 U.S. 591) and BLUEFIELD (262 U.S. 679) decisions of the U.S. Supreme Court, which decisions form the basis for present regulatory treatment of the cost of capital; (2) the model is founded on sound and generally accepted concepts of economic behavior; and (3) its application encourages the analyst to be explicit regarding the data, computations, and assumptions used in the analysis.

The costs of debt and preferred stock are contractual in nature and can be observed directly. The cost of a bond is the yield to maturity of its interest coupons and the amount due at maturity. The cost of preferred stock is the required dividend payment.

However, the cost of common equity cannot be observed since there is no contractual obligation for the issuers to pay any set amount of common dividends. Instead, the cost of equity, or the rate of return on investment necessary to induce investors to invest in that common stock, must be inferred from the actions of investors in the market.

The total rate of return on an investment in common stock is the present value of all future dividends plus the expected future sales price, divided by the purchase price. Given an expected stream of dividends during the period the stock will be held and an expected sale price at the end of that holding period, the investor can adjust the total rate of return to equal or exceed his required rate of return simply by paying the appropriate price for the stock. Thus, if we know, or assume, investors' expectations regarding dividend streams and future sales price, their required rate of return for a particular investment can be inferred from the price established in the market.

The DCF model embodying these basic concepts is developed algebraically as follows. 1/ In the DCF method we seek to infer the rate of return that recent investors have implicity attributed to a particular stock or group of stocks. That is, the market price at any time will reflect the implicit discount rate of those investors who trade the stock at that time. It is the rate of return that currently is sufficient to induce those people to invest in the equity stock.

Specifically, as shown in Equation 1, the current market price, p_o , of a share is found by discounting at rate, k, the stream of dividends, d_n, and the sale price of the share after n time periods, p_n.

(Eq. 1)

$$P_o = d_1/(1+k) + \ldots + d_n/(1+k)^n + P_n/(1+k)^n$$

Now, if we assume that dividends will grow at a constant rate per period, g, each of the dividends can be expressed as a product of the current dividends, d_o, as follows:

(Eq. 2)

$$P_o = d_o(1+g)/(1+k) + \ldots + d_o(1+g)^n/(1+k)^n + P_n/(1+k)^n$$

Rewriting equation 2:

1/See Jack Clark Francis, *Investments: Analysis and Management*, 3rd Edition, New York: McGraw Hill Book Company, pp. 264-288

(Eq. 3)

$$P_o = d_o(1+g)/(1+k) + \ldots + d_o(1+g)^n/(1+k)^n + d^o(1+g)^{n+1}/(1+k)^{n+1} + d_o(1+g)^{\infty}/(1+k)^{\infty}$$

If we further assume an infinite planning horizon, equation 3 can be simplified to:

(Eq. 4)

$$P_o = d_1/(k-g)$$

Which can be rewritten:

(Eq. 5)

$$k = (d_1/P_o) + g = (d_o(1+g)/P_o) + g$$

Equation 5 tells us that "k", the investor discount rate, or required rate of return, or cost of equity, equals the current dividend yield projected one period forward plus the rate of growth of dividends. The current dividend yield is known and the growth rate, g, can reasonably be projected from historic dividend data.

Alternatively, if we assume continuous compounding, Equation 3 may be rewritten as:

(Eq. 6)

$$k = (d_o/P_o) + g$$

Equation 6 days that the current investor discount rate is given by the current dividend yield plus the rate at which dividends are expected to grow.

The final form of the model says that the investor's required rate of return, or the investor discount rate, is equal to the current dividend yield plus the expected future growth rate of dividends.

METHODOLOGY OF THIS STUDY

With regard to the specific task of estimating GPU's cost of equity capital for each of the years 1980-1984, the following questions must be answered. Given that the very concept of cost of equity implies an empirical determination from market data that are inherently historical in nature, how can a forecasted cost of equity be estimated?

Regarding this question, the cost of equity is properly inferred from market data which result from the pricing decisions of investors. Unfortunately, market data cannot be measured prospectively. Also, the cost of equity depends not only on the perceived risk of investment in a company's equity but also on economic conditions in general and interest rate levels in particular at the time the investment is made. Since future costs of equity clearly will depend on future economic conditions, forecasted costs of equity must be based on forecasted economic conditions.

Various economic indicators are regularly forecasted by firms such as Chase Econometrics, Data Resources,Inc., and Wharton Econometric Forecasting Associates. For example, Chase Econometrics forecasts the Federal funds rate, 91-day Treasury bill rate, 4-6 month commercial paper rate, prime commercial bank rate,and the AA utility bond rate. Wharton and Data Resources each forecast a larger number of similar series.

The component of the DCF model sensitive to the level of interest rates is dividend yield. Projections of GPU's cost of equity could be made using the DCF model if GPU's dividend yield (currently zero because GPU has suspended dividends) could be estimated as a function of forecasted interest rates, as expressed by one or more of the series regularly forecasted by the firms mentioned above.

Investors' long term growth expectations should be sensitive to temporary economic conditions; growth rates are much more stable over time than are dividend yields. Hence, growth expectations which are reasonable today are probably close to those likely to be held by investors during the 1980-84 forecast period.

Assumptions used in forecasting GPU's cost of equity

GPU's future cost of equity was estimated using the DCF model and the following assumptions:

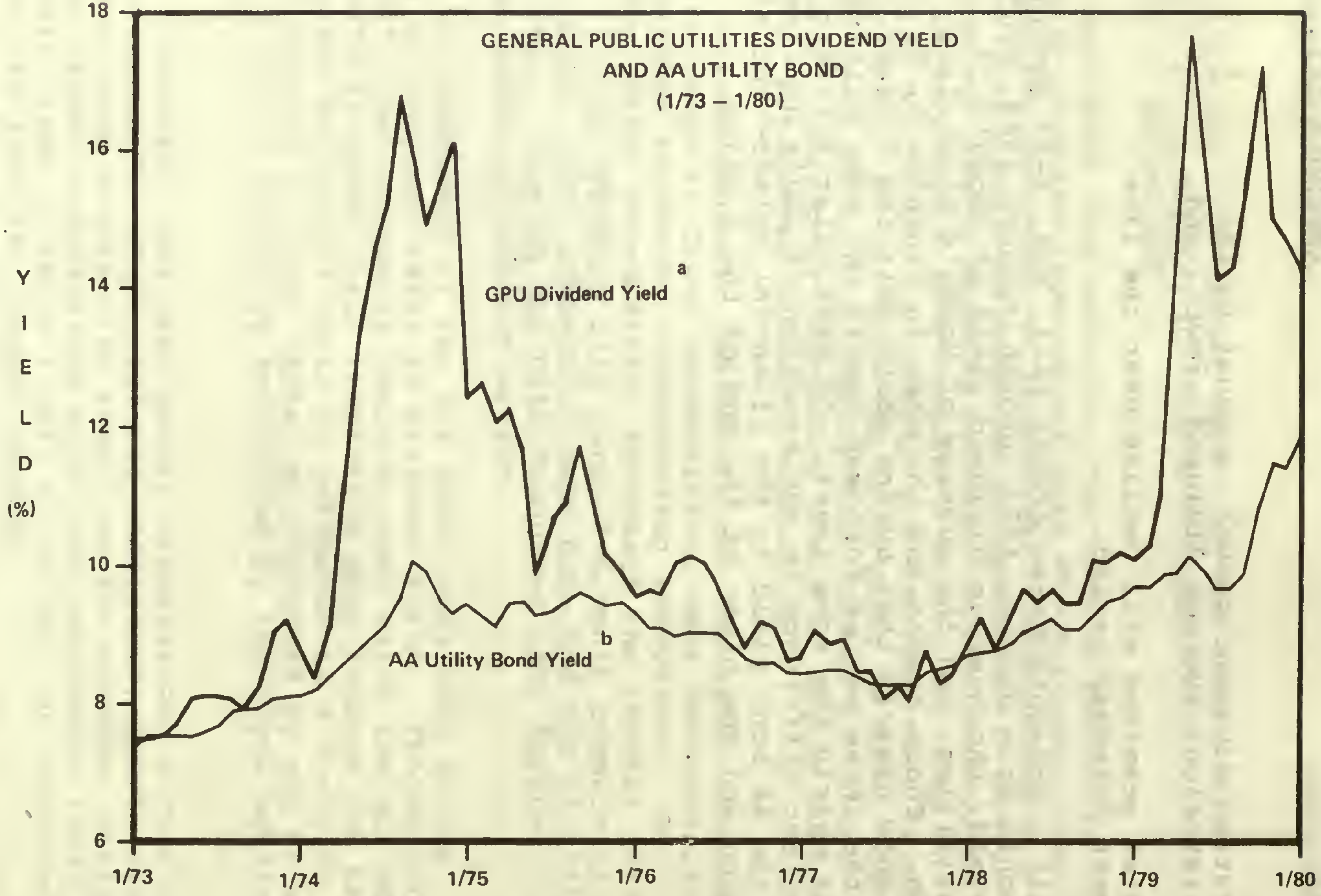
a) Future dividends yields will equal forecasted AA utility bond yields plus a risk premium,

b) Future dividend growth is equal to the historical average dividend growth, and,

c) Risk premiums will decline over the five year forecast period.

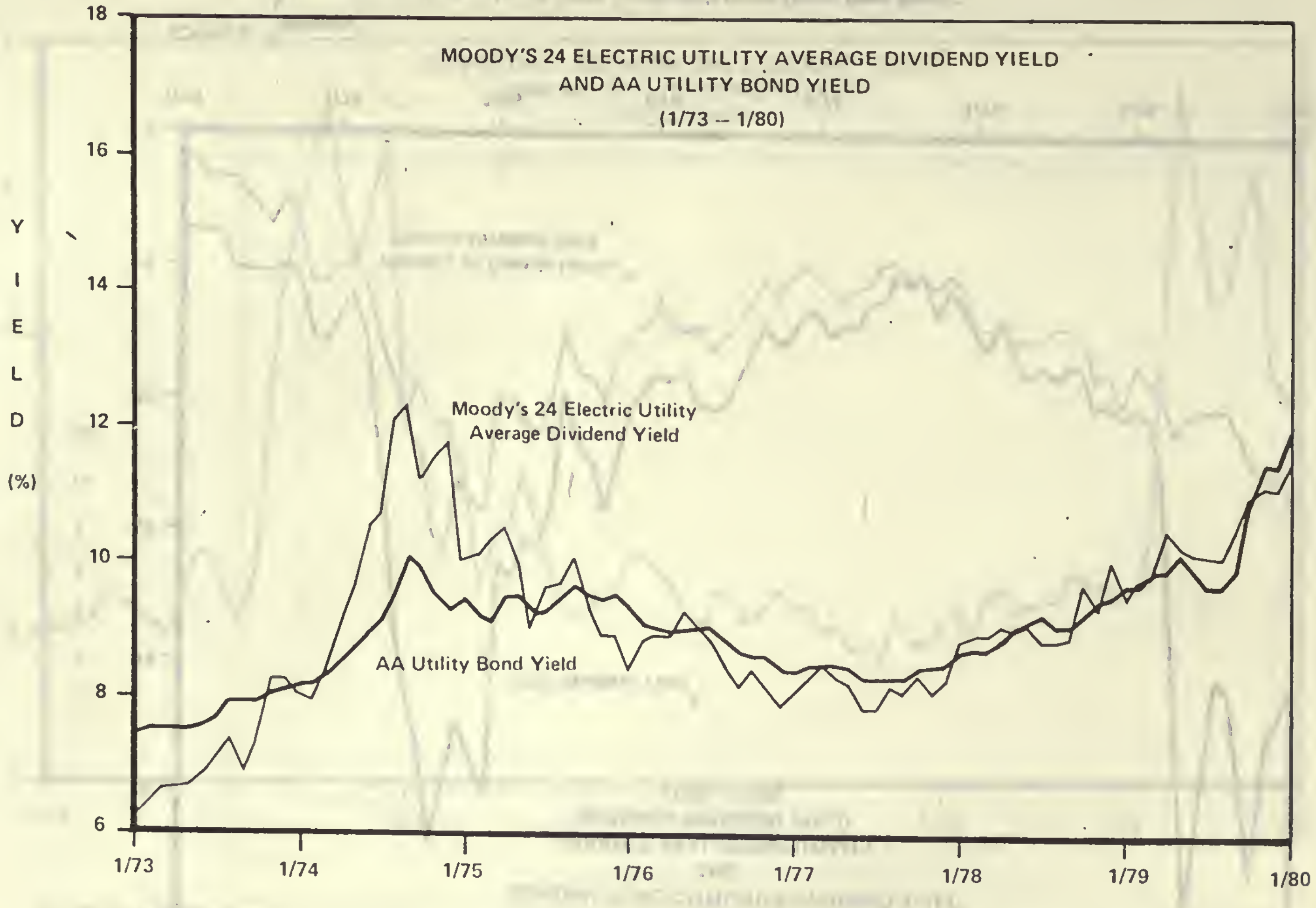
Exhibit A presents three graphs (A-1, A-2, A-3) showing, for each month from January 1973 through January 1980, GPU's dividend yield, the average dividend yield of Moody's 24 electric utilities, and the average of Moody's AA utility bond yields. Those graphs,and the ones in Exhibits B, C, D, and E, show clearly that during about half the 7 years (1973-79) the three series followed nearly the same pattern and were at nearly the same level. Of particular interest is the apparent difference in the reaction of GPU's dividend yield and the AA bond yield to two financial crises--one at the beginning and the other at the end of the 7 years.

EXHIBIT A-1



SOURCE: [a] Barron's
[b] Moody's Public Utility Manual, 1979 and Moody's Public Utility News Reports

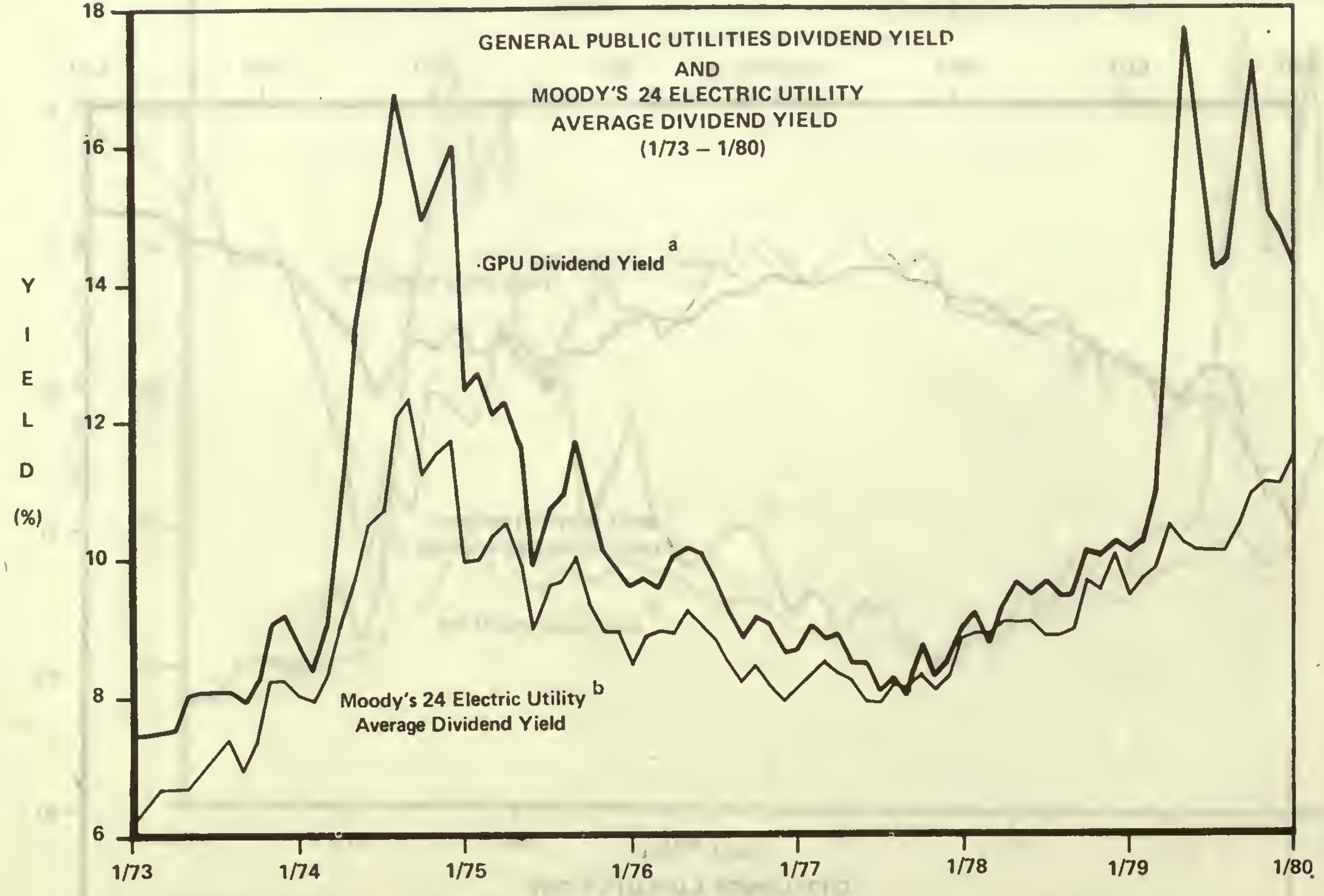
EXHIBIT A-2



MOODY'S 24 ELECTRIC UTILITY AVERAGE DIVIDEND YIELD
AND AA UTILITY BOND YIELD
(1/73 – 1/80)

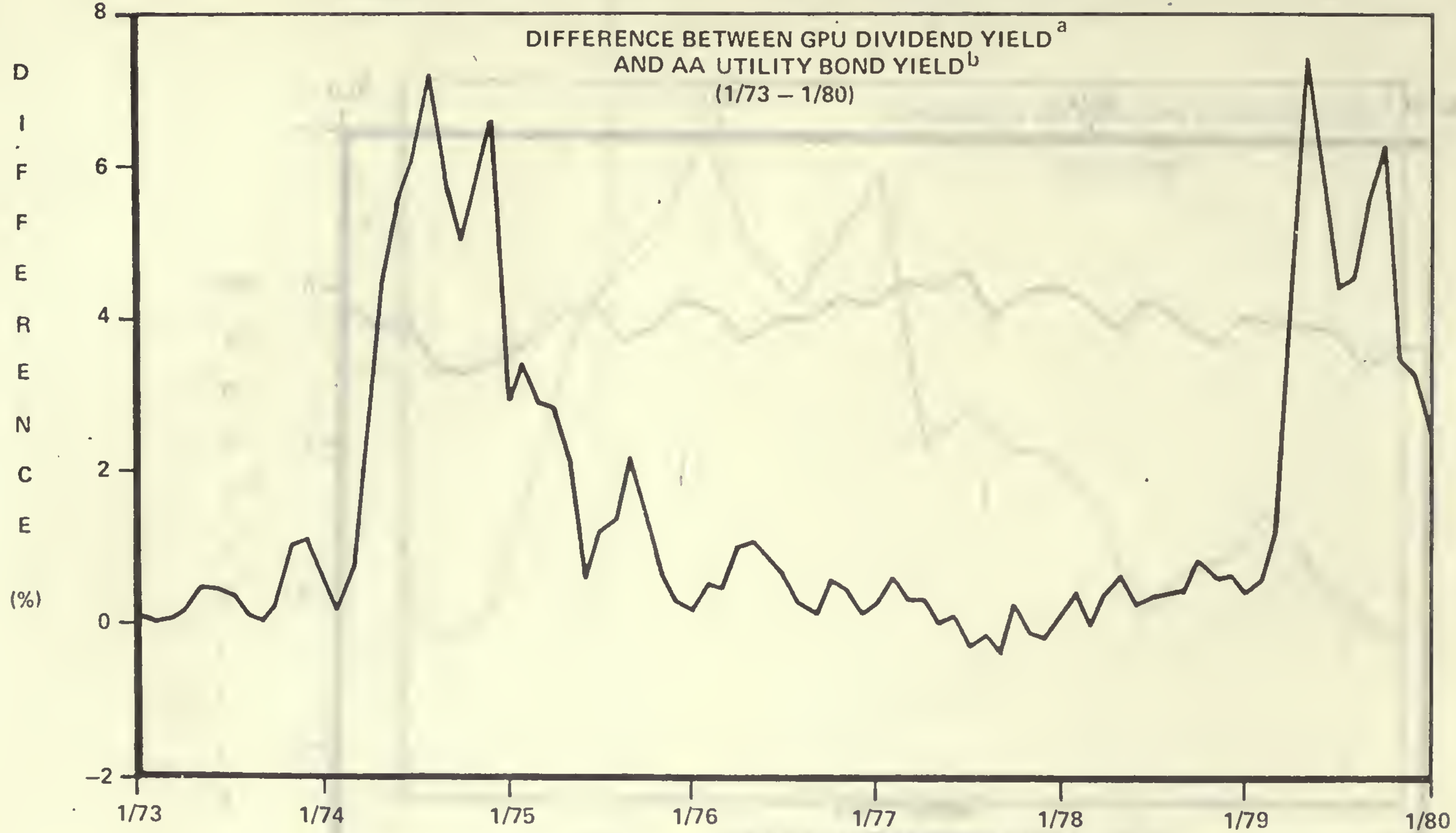
SOURCE: Moody's Public Utility Manual, 1979 and Moody's Public Utility News Reports

EXHIBIT A-3



SOURCE: [a] Barron's
[b] Moody's Public Utility Manual, 1979 and Moody's Public Utility News Reports

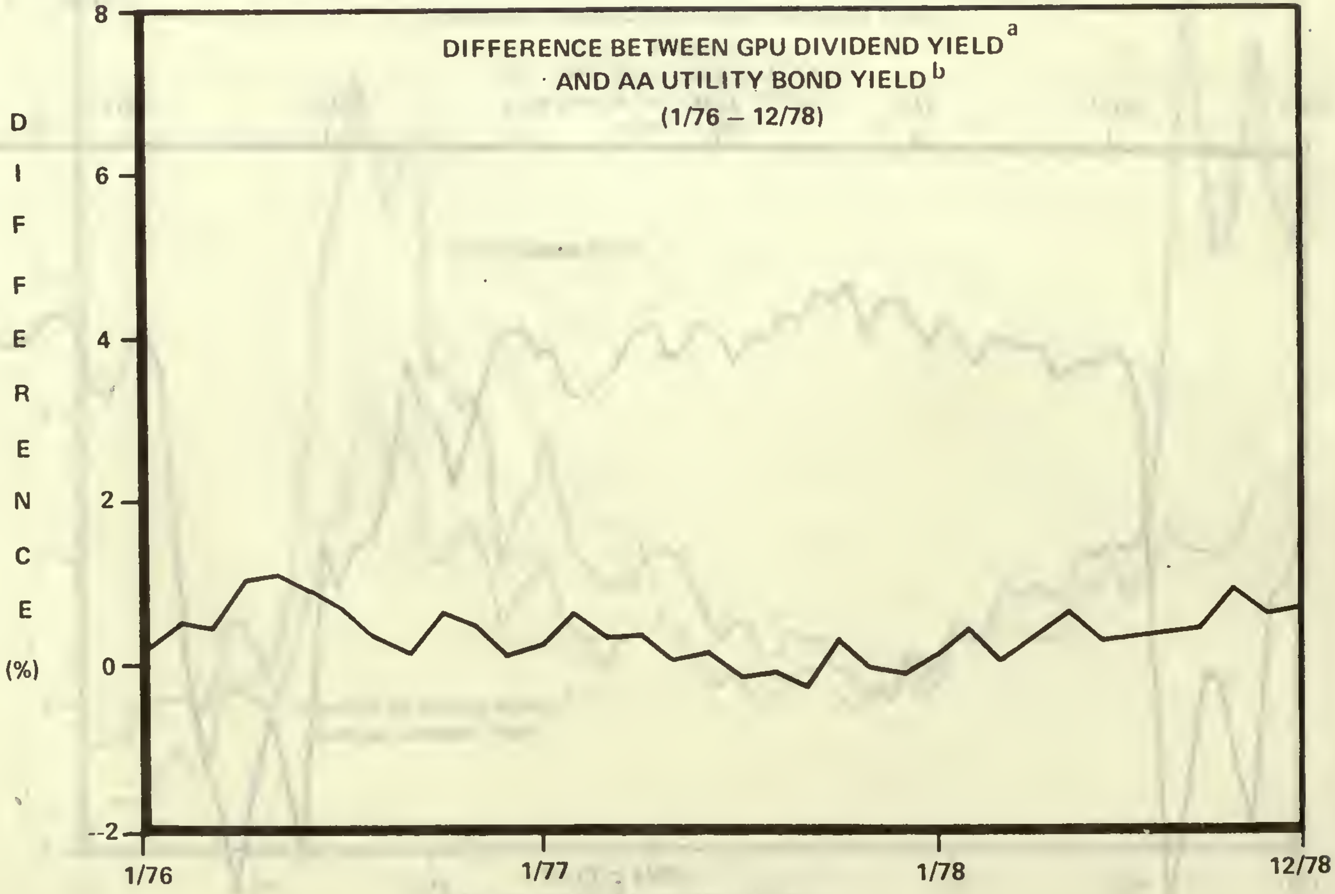
EXHIBIT B



DIFFERENCE BETWEEN GPU DIVIDEND YIELD[a] AND AA UTILITY BOND YIELD[b] (1/73 – 1/80)

SOURCE: [a] Barron's
[b] Moody's Public Utility Manual, 1979 and Moody's Public Utility News Reports

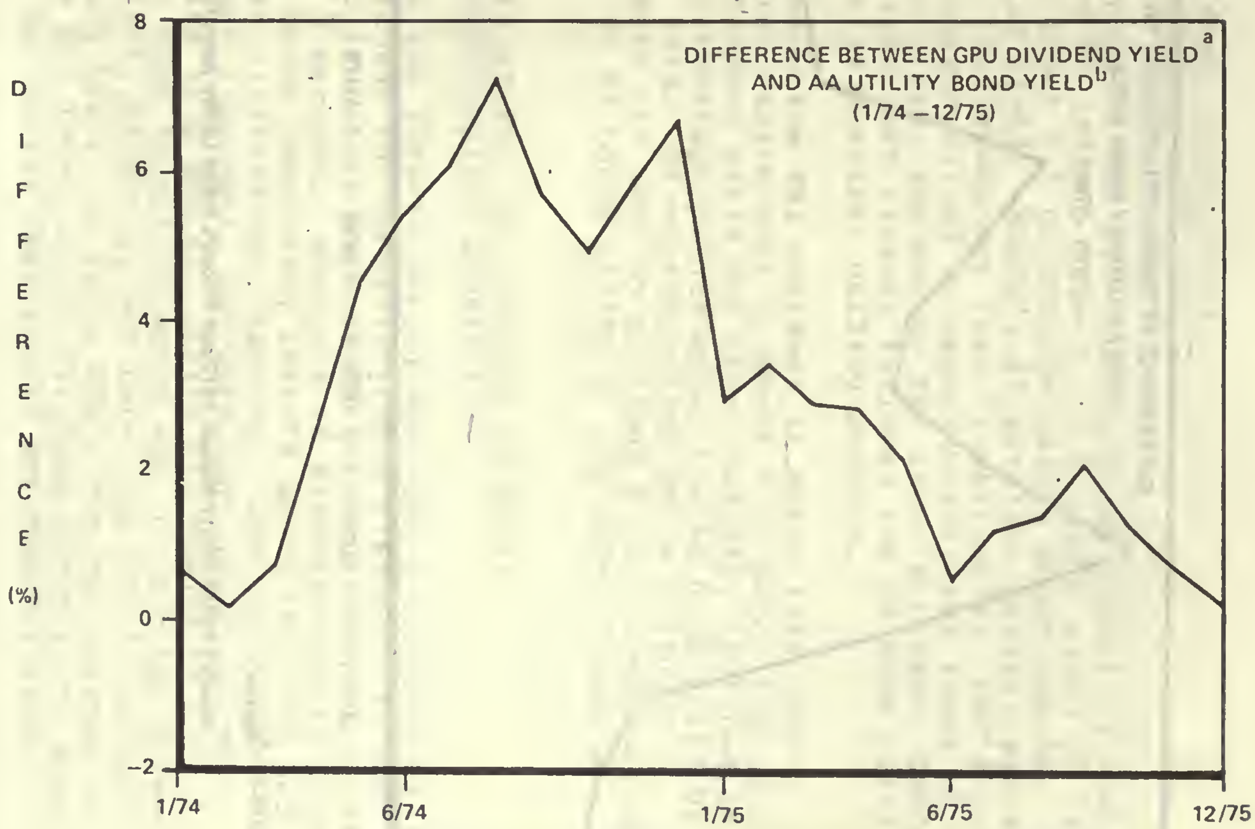
EXHIBIT C



DIFFERENCE BETWEEN GPU DIVIDEND YIELD[a] AND AA UTILITY BOND YIELD[b]
(1/76 – 12/78)

SOURCE: [a]Barron's
[b]Moody's Public Utility Manual, 1979 and Moody's Public Utility News Reports

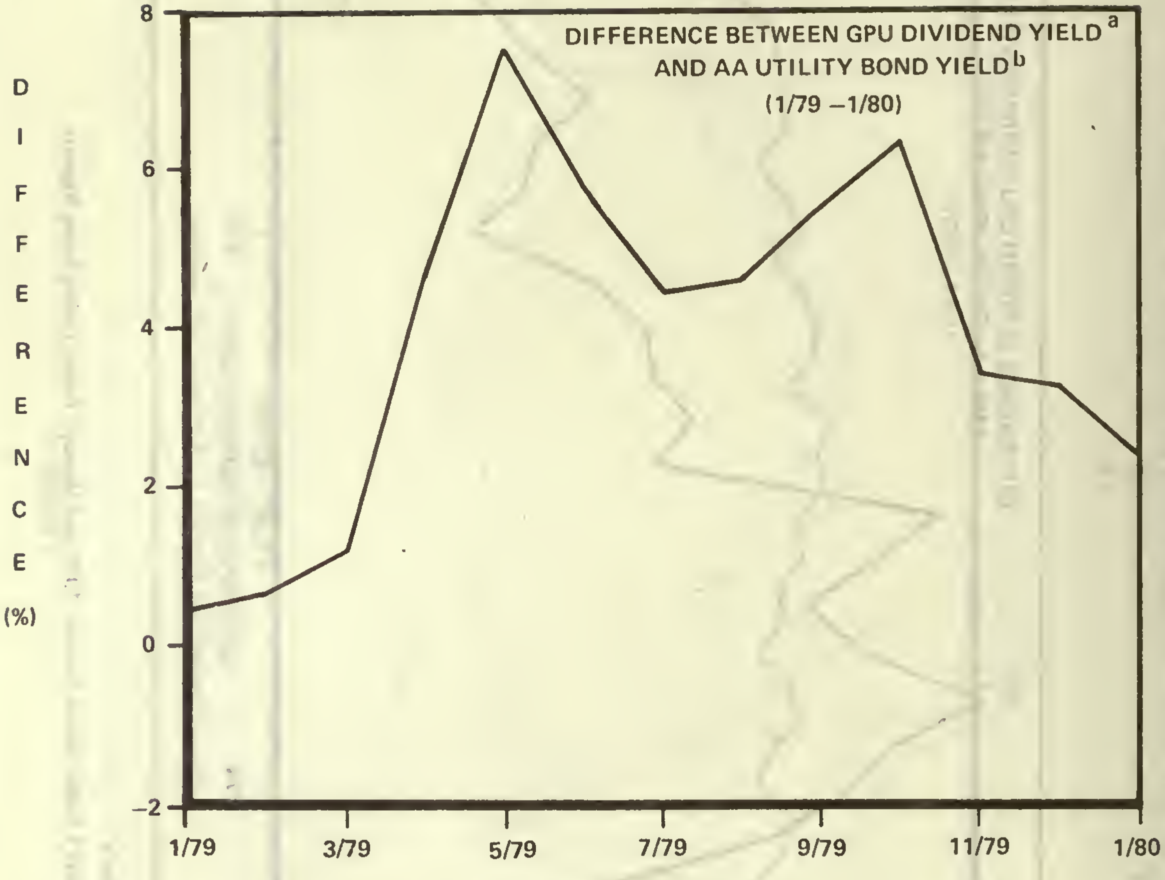
EXHIBIT D



DIFFERENCE BETWEEN GPU DIVIDEND YIELD[a] AND AA UTILITY BOND YIELD[b]
(1/74 –12/75)

Source: [a] Barron's
[b] Moody's Public Utility Manual, 1979 and Mcody's Public Utility News Reports

EXHIBIT E



SOURCE: [a] Barron's

[b] Moody's Public Utility Manual, 1979 and Moody's Public Utility News Reports

GPU's dividend yields closely follow AA utility bond yields

The shock of the Oil Producing and Exporting Countries oil embargo of 1974-75 caused the dividend yield of GPU to jump to about 7.5 percentage points above the AA utility bond yield. Moody's 24 electric utility average yield also increased, but less dramatically. GPU's yield then gradually declined to approximately the level of the AA bond yield, and during the 1976-78 period, GPU's dividend yield very closely followed the AA bond yield of the Moody's 24 electric utility average.

Following the TMI accident in March 1979, GPU's dividend yield again shot up about 7.25 percentage points above the AA bond yield,and then gradually declined to about 2.8 percentage points above the AA bond yield by the end of 1979. Of course, since GPU's dividend omission there has been no dividend yield to measure or to compare to AA bonds yields or any other financial series.

GPU's future growth rate assumed to equal its average historical growth rate

During the 1976-78 period when GPU's dividend yield closely followed the AA utility bond yields,it is very likely that investors expected a future growth rate of about 1 to 2 percent. Analysis of historic growth rates during the years preceeding 1976-78 shows that GPU had growth rates of dividends, earnings, and book value between 1 and 2 percent, but with many negative rates (see Exhibits F, G and H). After the events of 1979 it is unlikely that investors would now, or for the foreseeable future, expect growth rates for GPU to exceed the 2-percent level. In fact, GPU's own projections for 1982-84 are for level annual dividend payments of about one dollar per share, nearly half the pre-TMI rate.

Although there clearly is little prospect of dividend growth during the five-year forecast period, it is possible that by the end of that period (say 1983 or 1984) investors once again may expect modest dividend growth. We assume investors will expect, during each of the forecast years, a future (from that year on) dividend growth rate of between 1 and 2 percent. This assumed average growth rate of 1.5 percent for GPU compares with an electric utility industry average annual historic growth rate in the 3- to 4-percent range.

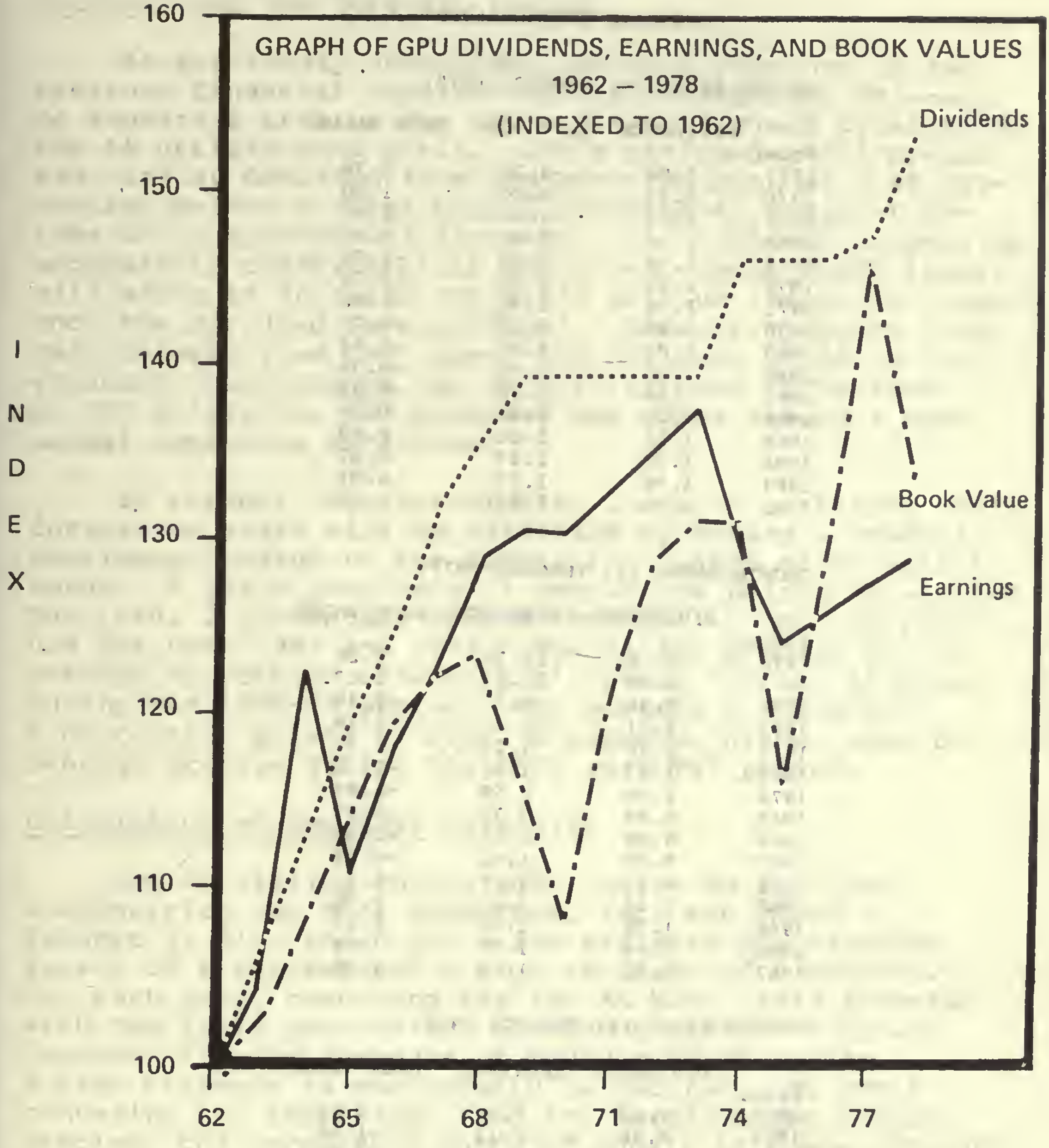
Exhibit F

GPU Dividends, Earnings, and Book Values (1962-1978)

Year	Declared Dividends	Earnings	Book Value
1962	1.15	1.71	14.96
1963	1.22	1.75	15.57
1964	1.3	1.85	18.33
1965	1.37	1.95	16.71
1966	1.43	2.04	17.78
1967	1.52	2.09	18.34
1968	1.57	2.11	19.21
1969	1.6	2.	19.56
1970	1.6	1.83	19.5
1971	1.6	2.08	19.81
1972	1.6	2.21	20.31
1973	1.6	2.25	20.51
1974	1.68	2.25	19.37
1975	1.68	2	18.6
1976	1.68	2.2	18.81
1977	1.7	2.5	19.04
1978	1.77	2.3	19.19

Source: Value Line Investment Survey.

EXHIBIT G



GRAPH OF GPU DIVIDENDS, EARNINGS, AND BOOK VALUES
1962 – 1978
(INDEXED TO 1962)

SOURCE: Value Line Investment Survey

EXHIBIT H

HISTORIC GROWTH RATES

GROWTH RATES (%) THROUGH 1978:

From:	DIVIDENDS	EARNINGS	BOOK VALUE
1977	4.04	-8.33	0.78
1976	2.61	2.22	1.00
1975	1.68	5.47	1.06
1974	1.16	2.67	0.05
1973	1.54	1.49	-1.06
1972	1.51	1.10	-1.24
1971	1.38	1.35	-1.00
1970	1.22	2.23	-0.72
1969	1.07	2.07	-0.56
1968	1.03	1.65	-0.36
1967	1.09	1.38	-0.05
1966	1.29	1.25	0.24
1965	1.51	1.26	0.59
1964	1.74	1.37	0.57
1963	1.99	1.53	0.91
1962	2.25	1.66	1.20

GROWTH RATES (&) THROUGH 1977:

From:	DIVIDENDS	EARNINGS	BOOK VALUE
1976	1.18	12.78	1.22
1975	0.59	11.15	1.17
1974	0.36	4.11	-0.40
1973	1.21	1.88	-1.78
1972	1.28	1.23	-1.77
1971	1.17	1.52	-1.32
1970	1.08	2.58	-0.89
1969	0.89	2.31	-0.65
1968	0.88	1.75	-0.39
1967	0.98	1.41	-0.02
1966	1.23	1.26	-0.31
1965	1.49	1.27	0.70
1964	1.75	1.39	0.67
1963	2.04	1.57	1.04
1962	2.32	1.71	1.35

GROWTH RATES (%) THROUGH 1976:

From:	DIVIDENDS	EARNINGS	BOOK VALUE
1975	0.00	9.53	1.12
1974	0.00	-1.12	-1.46
1973	1.46	-1.85	-3.00
1972	1.46	-1.26	-2.51
1971	1.25	-0.05	-1.65
1970	1.05	1.76	-1.00
1969	0.87	1.62	-0.68
1968	0.86	1.10	-0.36
1967	0.98	0.82	0.08
1966	1.28	0.74	0.45
1965	1.57	0.84	0.89
1964	1.87	1.05	0.82
1963	2.18	1.31	1.22
1962	2.48	1.50	1.55

Risk premium is expected to decline over the forecast period

As previously described, investor response to two previous financial shocks--the oil embargo and TMI--was to require a premium for GPU's dividend yield relative to the AA utility bond yield. GPU's dividend yield premium had already declined from its post-TMI high of 7.48 percentage points to less than 3 percentage points at the time GPU suspended its dividend. The dividend suspension undoubtedly constitutes an additional shock which likely will serve to increase the yield premium investors require once the dividend is reinstated. However, judging from past behavior, we can expect the dividend yield to fall gradually back toward the AA utility bond yield level as GPU solves its TMI problems and moves toward a more normal operating condition.

To reflect this anticipated investor behavior, GPU's forecasted yield will be estimated by adding a gradually declining premium to the forecasted yields of AA utility bonds. A yield premium of 4 percentage points is assumed for 1980, 2 percentage points for 1981, 1 for 1982, and 0.4 for both 1983 and 1984. The latter premium is the average difference between GPU's yield and the AA yield during the 1976-78 period. The assumed premium of 4 percentage points in 1980 is somewhat higher than the average premium during the 1979 post-TMI period.

Calculation of the cost of equity

The AA utility bond yields forcasted by Chase Econometrics and Data Resources, Inc. are shown in Exhibit I. Also shown are a low estimate for expected growth of 1 percent and a high estimate of 2 percent. For each year, combining the low AA bond yield forecast with the yield premium and the low estimate of growth produces the low forecast of GPU's cost of equity. A high estimate is analogously calculated. To avoid conveying the impression that the forcasts are highly precise, the forecasted costs of equity have been rounded to the nearest whole percentage point.

Exhibit I

Forecasted Yields, Growth Rates, and Cost of Equity (COE) General Public Utilities

Year	Yield Premium	Low Growth	High Growth	Chase est. a/	DRI est. b/
1980	4.0	1.0	2.0	13.38	13.28
1981	2.0	"	"	12.65	12.32
1982	1.0	"	"	12.12	12.49
1983	0.4	"	"	11.60	12.54
1984	0.4	"	"	10.28	12.16

Year	Low COE est.	High COE est.	Mean COE est.	Rounded COE est.
1980	18.28	19.38	18.83	19.00
1981	15.32	16.65	15.98	16.00
1982	14.12	15.49	14.81	15.00
1983	13.00	14.94	13.97	14.00
1984	11.68	14.56	13.12	13.00

Source: a/Chase Econometrics, U.S. Macroeconomics Forecasts and Analysis, First Quarter 1980.

b/Data Resource, Inc., Spring 1980.

We have not attached any measure of confidence to the forecasts; we note only that all forecsts have some uncertainty associated with them, and that in recent years economic forecasting has not had a particularly good record. However, even though a particular forecast may not--indeed, doubtless will not--be entirely accurate, the task at hand nevertheless requires that a forecast be used. Just as assumptions used in models may not be entirely accurate or realistic, the best assumptions must be used if the best decision is to be made; so, too, the best forecasts are better used than none at all.

It should be noted that the Chase and Data Resources forecasts are in fairly close agreement through 1982, after which they diverge for 1983 and 1984. Such a situation is not surprising since the longer the forecasting horizon, the more the uncertainty and the greater the effects of differing assumptions.

The net result of the analysis is that our best estimates of future costs of equity for GPU are:

Year	Estimated GPU cost of common equity
1980	19%
1981	16
1982	15
1983	14
1984	13

Chapter 4

Reactor Operator Training: The Utilities' Role

By

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Congressional Research Service
The Library of Congress

Washington, D.C. 20540

REACTOR OPERATOR TRAINING--THE UTILITIES' ROLE

Prepared for the
Subcommittee on Nuclear Regulation
Senate Committee on Environment and Public Works

Donna S. Kramer
Office of Senior Specialists
Congressional Research Service
July 21, 1980

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FOREWORD

Training of nuclear power plant operators has been a requirement of the Government's reactor licensing process for almost three decades. Training by nuclear utilities must comply with government regulations and affords an opportunity to develop elite, well-trained and professionally agresive operating staffs. This training can be obtained from commerical sources(vendors) or, in-house programs, or a combination.

As a result of the accident that occured at Three Mile Island, operator training is getting increased attention. Two separate investigations were established by the U.S. Government to examine the accident at TMI. One was the President's Commission on the Accident at Three Mile Island (The Kemeny Commission); the other the U.S. Nuclear Regulatory Commission Special Inquiry Group (The Rogovin Report). With respect to operator training the Kemeny Commission report stated that:

> The training program was quantitatively and qualitatively understaffed as well as conceptually weak; emphasis was not given to fundamental understanding of the reactor and little time was devoted to instruction in the biological hazards of radiation. The content was left to the instructors who had no greater formal education qualification than those of their students. 1/

The Rogovin Report concluded:

> Some previous analyses of the Three Mile Island accident have been read to attribute it to "operator error". We reject this conclusion as being incomplete. While there is no question that operators erred when they interfered with the automatic operation of the high pressure

---

1/ The President's Commission on the Accident at Three Mile Island, John Kemeny, Chairman. Report of the Commission; the Need for Change; The Legacy of TMI. Washington, D.C., U.S. Govt. Print. Off., 1979. p. 201.

> injection (HPI) system even though conditions that had initiated the system (low pressure) persisted, we believe there were a number of important factors not within the operators control that contributed to this human failure. These included inadequate training, poor operator procedures, a lack of diagnostic skill on the part of the entire site management group, misleading instrumentation, plant deficiencies, and poor control room design. For these failings the industry and the NRC must share responsibility with Met. Ed. [2]

This paper illustrates how the nuclear industry viewed operator training before and after Three Mile Island, and its response to the accident with respect to the future of training operators. It is divided into two parts. The first examines how utilities have recruited, trained, and retrained their nuclear power plant operators. The second section looks at the response of the nuclear industry to Three Mile Island with respect to training. The treatment here does not extend to training and possible licensing for other technical personnel at nuclear power plants, such as instrument repairers, mechanics, electricans or plumbers who work on the primary systems of these plants, or to nuclear engineers or persons in key technical management positions at the plant and in the upper levels of organization. Since it seems likely that training for such personnel sooner or later will attract Congressional scrutiny this matter could be the subject of future analysis.

2/ U.S. Nuclear Regulatory Commission. Special Inquiry Group., Mitchell Rogovin, Director. Three Mile Island; A report to the Commissioners and to the Public. Washington, D.C., 1980, 2 vols. NUREG/CR-1250. p. 102.

OPERATOR RECRUITMENT AND TRAINING

INTRODUCTION

The training of nuclear reactor operators has been an essential aspect of nuclear facility licensing since the enactment of the Atomic Energy Act of 1954. Section 107, as amended of that Act specifies that with respect to operators licenses, the U.S. Nuclear Regulatory Commission shall 3/

a. Prescribe uniform conditions for licensing individuals as operators of any of the various classes of production and utilization facilities licensed in the Act;

b. Determine the qualifications of such individuals;

c. Issue licenses to such individuals in such forms as the Commission may prescribe and;

d. Suspend such licenses for violations of any provision of this Act or any rule or regulation issued there under whenever the Commission deems such action desirable.

Regulations to implement Section 107 are promulgated in Part 55 Title 10 of the Code of Federal Regulations (10 CFR 55). Section 10 CFR 55.54(i-1), which became effective in 1973, specifically requires requalification or retraining programs for licensed operators.

From a professional point of view, training as defined by Forrest Remick, an ex-senior reactor operator, means to make a person proficient by instruction and practice, as in some art or profession or work. 4/ Training of operators,

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3/ Atomic Energy Act of 1954, as amended. P.L. 83-703, Sec. 107; 42 U.S.C 2137.

4/ Remick, Forrest. Training of Nuclear Facility Personnel, Boon or Boondoggle. Nuclear News, October 1975. v. 18. p. 77.

he continues, "should be directed towards operating the plant safely, including a detailed understanding of the plant, its equipment and instrumentation." 5/

Many kinds of personnel at a nuclear power plant and in a nuclear utility perform professional work as technicans or engineers. Depending on the operating philosophy of a utility's management, there are usually six levels of management personnel whose decisions and work can affect the safety and economy of plant operation. These include the plant superintendent, the assistant superintendent, the operations supervisor, the nuclear engineer in charge, the maintenance supervisor, and the instrument control engineer. In addition, six or seven shift supervisors together with eleven to fourteen operators who are at the controls, compromise the personnel who bear a direct heavy responsibility for plant operation. This analysis, as mentioned above, deals only with the nuclear power plant operators.

From the viewpoint of management, the first objective of training is to assure that operators are trained to safely and efficiently operate the nuclear power plants they control. A second objective is to prepare prospective operators to pass the Nuclear Regulatory Commission's examination. Since operator candidates may differ widely in education and experience, utilities must develop training that will aid students of different backgrounds and experience to learn what is needed to run the plant safely and efficiently. But first, where are these candidates recruited from?

SOURCES OF NUCLEAR POWER PLANT OPERATORS

The literature on supply and training of reactor operators is still rather sparse. Much of the following draws heavily upon several works that include proceedings of the first, second and third symposium on the training of nuclear facility personnel (1971, 1975, 1979).

5/ Ibid.

At present there are three sources of nuclear power plant operators, each having advantages and disadvantages. They include fossil-fuel power plant operators, ex-Navy personnel with nuclear experience and new hires with no power station or nuclear experience.

Fossil Power Plant Operators 6/.-- Operators of power plants that raise steam from oil, gas or coal combustion and who are capable of being retrained to run nuclear power plants can be a source of manpower. They can bring practical experience in steam systems, turbines, auxilary electrical systems, and the switch yard. The average age of these operators tends to be higher than the other two categories, and they may bring added technical maturity to the control room.

Naval Personnel 7/.-- Ex-naval personnel with nuclear training gained while in service usually have a fundamental grasp of the physics and principles of nuclear reactors plus extensive operating experience. However the types of reactors and the operating philosophies and practices of the nuclear navy differ greatly from those of commerical nuclear power plants. While well trained people now appear to be leaving the services relatively early in their careers, the utilities cannot expect the Navy to remain their principal source forever. The growth of the nuclear navy has slowed at a time when the number of new nuclear power plants coming into operation is increasing.

No Previous Experience 8/.-- New hires with no nuclear power operating experience can be an attractive source to a utility, particularly as more nuclear power plants start up. Some may have pertinent education because some

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6/ Proceedings of the Second Symposuum on Training of Nuclear Facility Personnel (May 11-14, 1975) p. 187-191.

7/ Ibid.

8/ Ibid.

regional community colleges and technical schools are now offering preliminary nuclear training leading to an Associates Degree in Nuclear Technology, with specialization in the technical work or plant operations. Some of these schools have worked out cooperative programs with neighboring utilities for alternate quarters of work and study. Such arrangements give a utility an opportunity to observe a student's on-the job performance before making an offer of permanent employment. Although a high school graduate may require the most training, in the long run, he or she may be the most desirable source for future staffing.

Sustaining Operator Qualifications.-- A nuclear utility has to provide continuing training for its reactor operators. Not only is this required by the NRC, but by the utilities in voluntary standards of the American Nuclear Society. According to voluntary standard ANS 3.1, 9/ training programs are to be kept up to date to reflect plant modifications, changes in procedures, indust wide operating experience, and regulatory changes. A continuing program is needed after plant startup to train replacement personnel, to requalify operator and to ensure that operating personnel remain proficient. 10/

Most of the utility training effort, expense and time must be devoted to the reactor operators, with the remainder directed towards other technical staff

SELECTION STANDARDS

Selection among candidates is a vital matter for nuclear utilities. Regardless of source, all applicants must be screened to insure a high probability of success in training and satisfactory job performance. Although there are no NRC standards which utilities have to meet in hiring operators,

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9/ Standard for Qualification and Training of Personnel for Nuclear Power Plants; Proposed American National Standard. La Grange Park, Ill.: American Nuclear Society. ANSI/ANS-3.1 Dec. 1979. 38p.

10/ Ibid. p. 22.

there are voluntary ones. Moreover, the screening techniques used must satisfy existing statutory and regulatory requirements for all industrial recruitment.

Before looking further at selection, it is important to mention two organizations that coordinate the development of voluntary industrial standards for many aspects of nuclear power including those for selection and training of personnel. These are the American National Standards Institute and the American Nuclear Society.

American National Standard Institute (ANSI) 11/.-- ANSI is a federation of over 200 voluntary organizations representing almost every technical discipline, every facet of trade and commerce, organized labor, and consumer interests. ANSI members together with representatives from Federal, state and local governments attempt to coordinate development of voluntary standards and to provide a clearinghouse for information on national and international standards. ANSI itself does not write standards. Rather it provides the mechanisms for coordinated development and recognition of voluntary standards. Its procedures culminate in publications of American National Standards that represent a consensus of affected interests.

The principal organs of ANSI include:

A Board of Standards Review which approves standards as American National Standards, and acts on withdrawal and reaffirmation for a standard when it finds that a consensus exists for approval, reaffirmation, or withdrawl;

An Executive Standards Council which manages standards development activities coordinated by ANSI. Its duties include developing procedures and criteria for management; development, approval and withdrawal of standards; initiating standards projects and defining their scope; stimulating organizations and

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11/ ANSI. Guide for the development of American National Standards, 1972. p. 5.

committees to complete standards development work expeditiously; and ensuring participation of the U.S. in international standards activities and in liaison with an International Standards Council. In carrying out its functions, the Executive Standards Council is assisted by twenty technical advisory boards (TAB's), each of which operates in a particular discipline or industrial sphere;

An Organizational Member Council, a Consumer Council and a Company Member Council provides communications between their members and constituents and ANSI's Board on programs and policies. They help to determine standards needs and stimulate Institute action to fill these needs;

An International Standards Council which is responsible for ANSI's international activities. It guides the Institute's interaction with voluntary international standards organizations; and

A Certification Committee that administers the accreditation or certification programs submitted to the Institute; fosters development of new certification programs submitted to the Institute; fosters development of new programs in response to demonstrated needs; collaborates with government and private organizations in the development of criteria and systems for accrediting certification programs; and advises the International Standards Council on U.S. participation in international activities.

The American Nuclear Society 12/.-- The American Nuclear Society was founded in 1954, and has a membership of 12,000 individual members and almost 250 organizations. Its main objective is the advancement of science and engineering for the many uses of the atom. The American Nuclear Society has been a leader in voluntary standards work since 1958. Today it is involved in the development of more than 160 standards for the industry. The Society's standards

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12/ Compilation of the American Nuclear Society Standards-(1977). The American Nuclear Society, LaGrange Park, Ill. p. 2-11.

work is carried out by a complex network of committees and subcommittees, which are briefly described below.

ANS Standards Committee.-- ANS standards are established by its ANS Standards Committee, whose purposes are to coordinate the work of several subcommittees; to adopt and promulgate Society standards; to recommend courses of action to the Society in matters concerning standards and practices, terminology and units relating to nuclear science and technology; and to represent the Society in activities with other organizations engaged in cooperative or similar activities. The Standards Committee is comprised of about 1,000 persons who donate their time and expertise to this effort.

N Committees.-- The N Committees were created by ANSI to examine important topics facing the nuclear industy. The ANS holds the secretariat for five of the N committees of the American National Standards Institute (ANSI). Chairman of the N Committees are appointed by the ANS and they, or their designated representative, are members of a Standards Steering Committee. These committees set voluntary standards for many aspects of nuclear power. Detailed information on these ANS committees appears in Appendix I.

The ANS Subcommittee on Operator Training.-- With respect to establishing standards for operator training; ANS subcommittee 3 in conjunction with representatives from the NRC drafted the voluntary standard ANS 3.1. 13/ The American National Standards Institute published them in draft, invited comment, and then returned the comments to ANS. These standards are currently available in draft only from ANS.

13/ Standard for Qualification and Training of Personnel for Nuclear Power Plants; Proposed American National Standard. La Grange Park, Ill.: American Nuclear Society. ANSI/ANS 3.1 Dec. 1979. 38 p.

NRC Use of Voluntary Standards.-- The NRC has supplemented its regulation with many regulatory guides. Compilance with these guides is not required by law, but they carry compelling weight. NRC may refer to and endorse voluntary standards in its guides. NRC's Regulatory Guide 1.8, "Personnel Selection and Training", 14/ specifies acceptable practices for utilities to follow selecting and training personnel, including operators. It endorses those standards approved by the ANSI Committee N.18, Design Criteria for Nuclear Power and by the ANSI Nuclear Technical Advisory Board.

Standards concerning emotional stability of reactor operators are included in Section 4.3 of ANSI 18.17, Industrial Security for Nuclear Power Plants. This voluntary standard requires an intensive investigation of the applicant's background and an interview of candidates by individual's professionally trained to detect indications of emotional stability. In addition, the standard requires continued observation by responsible supervisors for indications of aberrant behavior during the course of the work of their staff.

LAWS AFFECTING OPERATOR SELECTION

The Fair Credit Reporting and Family Education and Privacy Acts.-- Both the Fair Credit Reporting and the Family Education and Privacy Acts can affect a utility's investigation of the applicants background. As required by the Fair Credit Reporting Act, 15/ an applicant rejected on

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14/ U.S. Nuclear Regulatory Commission. Office of Standard Development. Regulatory Guide 1.8 Personnel Selection and Training. September 1975 (Available from the Commission only)

15/ U.S. Code Congressional and Administrative News. (P.L. 41-508) 91st Cong. 2nd session. pp. 1301-1326.

the basis of an investigation performed by others must be so advised in writing and a copy of the report upon which the rejection was based made available for his examination. The Family Education and Privacy Act 16/ requires written permission from the applicant before his school records may be released.

Civil Rights Act of 1964--Title VIII 17/.-- Guidelines for compilance with Civil Rights legislation as related to testing have been established by the Equal Employment Opportunities Commission. To meet the guidelines established by the EEOC, the validity of any tests or other instruments used in the selection or promotion of employees must be demonstrated.

TYPES OF TRAINING EMPLOYED BY THE NUCLEAR INDUSTRY

Ways of training new employees vary among nuclear utilities. The symposium literature found that virtually all use classroom instruction at the power plant or sometimes conducted by a local community college under contract. 18/ Outside consultants are sometimes hired to teach such subjects as the basic concepts of the behavior of radiation and radioactive materials, critically, and health physics. Usually some portion of lecture time is devoted to questions and answers so that a new employee can explore topics about which he is uncertain. An additional purpose of training is to create a feeling of confidence on the part of the student which can lead to more efficient plant operation.

16/ Ibid.

17/ U.S. Code Congressional and Administrative News. (P.L. 88-352) 88th Cong. 2nd session. p. 317.

18/ Proceedings of the first, second and third symposium on the training of nuclear facility personnel (1971, 1975, 1979). (Various pagings.)

Problems with Contracting for Training.-- The practice of contracting out training has the advantage of providing facilities and staff beyond the reach of some utilities. Indeed most utilities do not have the in-house capability to conduct all of the required training. Consequently, it is contracted out to either major nuclear manufactors or to companies that provide training services. 19/

It appears to be common practice for the utilities to depend on their training contractors to do whatever is necessary to meet NRC guidelines and to prepare operators to pass NRC examinations. They tend to look at the training contractor to provide trained personnel. On the other hand, the training contractors have sometimes taken the position that their job is to make information available and it is up to the student to absorb it. They also tend to wait for the utilities to tell them if they were producing an acceptable produc The net result of this loose coupling is diffuse training with the only measural test of success being the number of students who pass or fail the NRC license examinations.

Instructor Qualification.-- Considering that instructors are the heart of operator training, there is the question of instructor qualifications. An issue for the nuclear industry is whether voluntary standards alone are sufficient to assure well qualified instructors. Voluntary standards for the qualifications of training instructors are found in ANS 3.1 (4.4.7.2) 20/ The NRC has yet to issue guidelines for instructor qualifications. According to ANS voluntary standards 3.1 qualifications for instructors should include:

19/ For a listing of commerical suppliers of reactor operator training in the United States see Appendix II.

20/ Standard for Qualification and Training of Personnel for Nuclear Power Plants; Proposed American National Standard. La Grange Park, Ill.: American Nuclear Society. ANSI/ANS 3.1 Dec. 1979. 38 p.

Education: High school diploma and special education consistent with the materials being presented.

Experience: Experience consistent with the materials being presented.

Training: An NRC senior operator license, or if not licensed, as appropriate education for the training being conducted. Instructors who provide simulator instructions should hold a senior operator license for a simulator unit (PWR, BWR HTGR) or have been certified at an appropriate plant simulator.

Teaching ability: A demonstrated knowledge of instructional techniques and certification by the Training Manager as a qualified instructor for the material being presented.

The level of education and experience is particularly important for instructors who teach requalification courses. Working operators who attend requalification classes would distrust an inexperienced instructor. Some members in attendance at the seminars believed that being a licensed operator would also broaden the instructors knowledge, scope and enable him to be more versatile for teaching other phases of the training programs related to operations. 21/

They also stated that if a utility hires a vendor to do the training, then the vendor's instructors should be familar with the plant's facilities, particularly the control room procedures. Ideally, their instructors should visit the utilities plant to observe plant operation and discuss the scheduled training with the appropriate personnel. If changes are made in control room procedures either by the utility or the NRC, the training contractor should be made aware of them. 22/

Other Training Problems.-- Two commonplace problems for operator training before Three Mile Island the second symposium concluded appeared to have been the low priority given by some utilities to providing adequate space and

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21/ Proceedings of the first, second, and third symposium on the training of nuclear facility personnel (1971, 1975, 1979). (Various pagings.)

22/ Ibid.

given by some utilities to providing adequate space and equipment for training, and seeing to it that adequate scheduled time was available for training. 23/

Training requires space and equipment at the plant site. Class rooms and elementary equipment such as chalkboards, projectors and screens, and reference materials, are needed, but may be regarded as unnecessary expense by managers brought up in operating conventional power plants. With current pressures from state public utiltiy commissions to minimize cost of power, training programs are vulnerable to cutbacks. 24/

Another problem is that unless utility management can make a commitment to set aside training time for their employees and to require employees to attend, training may be scheduled on a catch-as-catch-can basis. "Today a 24-hour start-up delay for a plant costing $750-million costs about $100,000. In the case of operating a plant, a training manager must ensure that operators, through their knowledge of plant-system operations, can maneuver the plant efficiency while maintaining design operating conditions with minimum downtime." 25/

SCOPE OF TRAINING

Training in reactor operation extends to three categories of personnel as follows:

Senior Reactor Operators(SRO): Individuals who hold an NRC senior operator's license. Those who are required to have senior licenses could include plant management personnel and shift supervisors. Reactor Operators(RO): Individuals who hold an NRC operator's license. Reactor operators have the responsiblity for all facets of control room operation from the reactor to the electrical distribution.

23/ Proceedings of the second symposium on the training of nuclear facility personnel. (May 11-14, 1975). p. 182-183.

24/ Ibid.

25/ Ronald Maslo, Roberta Kessler and Neil MacArthur. Updating simulators' operating training: I. Electrical World March 15, 1980. p. 34.

Plant Management Personnel: Usually, management personnel who directly supervise reactor operators also should hold an NRC Senior Reactor Operator License. A possible exception would be the plant superintendent.

One objective of such training, as indicated earlier is to prepare such personnel for two kinds of NRC operator license examinations: cold licenses for operators in a plant being prepared for initial operations, and hot licenses for plants in operation.

(1) Cold License Examination: The NRC conducts license examinations for any senior operator or operator who will work on a reactor prior to core loading. The prerequisite for eligibility for this examination is a demonstrated competence for nuclear plant operation which can be shown in a number of ways such as holding a prior NRC license, prior nuclear operations experience, or completion of an approved training program.

(2) Hot License Examination: The NRC conducts hot license examinations for personnel who will operate a nuclear power reactor after the initial core loading has been accomplished. This examination may include a reactor startup by the license applicant.

TRAINING OPERATORS TO PASS NRC EXAMINATIONS

The following expanded discussion of training for NRC license examinations provides an idea of the content for such training. It draws heavily upon the Westinghouse Training Programs Catalogue, which divides training into four phases of training: fundamentals, operations, simulator training, and reviews and audits. The Westinghouse training, in turn, is keyed to voluntary ANS standards.

Phase I--Funadmentals.-- According to voluntary standard ANS 3.1 a fundamentals course for operators covers the theory of nuclear fission processes and reactor operation, it contains instruction in:

(1) Principles or reactor operation, including
    (a) Atomic structure and radioactivity
    (b) Nuclear reaction and the fission process
    (c) Neutron behavior and control of the fission process
    (d) Core thermal hydraulic design
(2) Design features of the nuclear power plant
(3) General operating characteristics of the nuclear power plant
(4) Reactor instrumentation and control systems
(5) Radiation control and safety provisions
(6) Fundamentals of heat transfer, thermodynamics and fluid flow related to transient analysis.

The plan of this first phase is to introduce the trainee to the fundamentals of nuclear power plants through lectures and actual reactor operations. The lecture plan features thorough and comprehensive presentation of atomic nuclear and pressurized water reactor core physics. A sampling of the subjects covered include molecular and atomic structure, the nucleus and elemental particles, atomic numbers and the periodic table, the fission process, neutron flux, neutron leakage and reflector savings. Related lectures include health physics, coolant chemistry, basic reactor systems, plant operation, and engineering concepts. Material on core design, and excess reactivity loading, fuel burnup, soluble boron control, moderator temperature effects, fuel temperature affects, poison effects, radiation safety calculations, radiation detection, and biological effects of radiation are also included.

Westinghouse training in actual reactor operations during this phase is conducted in a small tank type reactor of minor power output. Here the trainee does core loading exercises and experiments. Ten of these excercises are required for a student to take the NRC cold license examination.

Excercises on low power reactors include approach to criticality, reactor shutdown and normal reactor startup, control rod use and calibration, step and ramp reactivity changes, and verification of predicted neutron level changes. It is in this phase that the instructors concentrate on converting classroom information into operational knowledge directly applicable to reactor operations.

The fundamental phase is perhaps the most essential one. If the student does not grasp the basic information here, he will not do well later or in the NRC license examinations. As is true in all phases of this training, quizzes and examinations are frequent in order to assure the student and the instructor that the necessary information is being grasped.

Phase II--Operations.-- During this phase the trainee works in a power plant under close supervision. All trainees take the phase, although trainees with experience may spend less time here if their instructors find they are qualified to go on to the next phase.

During the first few weeks of Phase II, trainees are introduced to the plant they will be licensed to operate. In the weeks that follow, they make a detailed study of the plant, reinforced with walk-throughs, with the instructor remaining with them at all times. The instructor is able to cover operational information and is available for questions if they arise.

The purpose of the operational phase is to give the trainee sufficient background to allow him to fully understand the operational training that follows.

Phase III--Simulator Training.-- After successfully completing Phases I and II a trainee begins training on a simulator. The concept here is to provide hands on practice with safe replicas of the controls the operator will use in the power plant. For additional information on simulators see page 18-22.

The NRC and the nuclear utilities both attach importance to simulator training as a way to expose trainees both to routine and unusual situations in power reactor operations. Along with the aviation industry the nuclear industry sees simulator training as a way to prepare operators for the unusual. However, training is not a magic answer, nor does possession of or access to a simulator mean that the training will be adequate.

Phase IV-- Pre-License Reviews and Audits.-- This phase is the last in the preparation of licensed candidates who are taking the NRC Reactor and Senior Operator License examinations. During this time the trainee is given an intensive review of previous courses and simulator training. Audit examinations, administered and patterned in the same manner as the NRC examination are given to prepare the trainee for the final test.

RETRAINING OF OPERATORS

The NRC requires in 10 CFR 50.54 (i-1), that a utility must have in effect an operator retraining program within three months after issuance of an operating license. According to 10 CFR 55.32, each operator and senior operator's license expires two years after the date of issuance and they must be relicensed in order to continue in their work. Retraining programs are intended to maintain proficient and safe operations by licensed reactor operators and senior reactor operators.

The industry has set voluntary standards for retraining in ANS 5.5.1 (Retraining of Personnel Licensed by the NRC). 26/ It specifies that annual retraining shall include classroom lectures, on-shift discussion, individual operator evaluation, and simulator retraining. Retraining is an on going process.

26/ Standard for Qualification and Training of Personnel for Nuclear Power Plants; Proposed American National Standard. La Grange Park, Ill., American Nuclear Society. ANSI/ANS-3.1 Dec. 1979. p. 29.

As with reactor operator training, retraining can be provided by the utility itself or by contractors. The ANS voluntary standards state that the retraining program is to consist of:

Lectures.-- The subjects covered in retraining lectures typically include refresher course materials in reactor physics, normal, abnormal and emergency operating procedures, plant mechanical systems, emergency plans and procedures, administrative controls and operational quality assurances, annual examination and review, instrumentation and control systems, chemistry and containment systems, fire protection, secondary systems, radiation protection, fuel handling and refueling. The ANS voluntary standard states that "training aids such as video tapes and films may be used. However, instructors are to participate in at least 50% of the lecture series." 27/

On-Shift Discussions.-- These discussions are to be held approximately two hours per evening, once a week, when feasible. Topics for discussion include normal, abnormal, and emergency operating procedures, technical specifications, design changes, procedure changes, license changes, and emergency plant and implementing procedures.

Individual Operator Evaluations.-- The primary purpose of this phase is to evaluate the knowledge of each operator being retrained. Methods of evaluation include, quizzes and drills. Quizzes are to be conducted weekly. Drills, are also to be conducted semi-annually to ensure that the operators continue to react properly under normal, abnormal or emergency situations. Drills are simulated and the operator is required to walk through the procedures to simulate plant recovery from shut down.

27/ Ibid. p. 30

Simulator Retraining.-- Retraining on a simulator can last anywhere from one to two weeks. Routine procedures and malfunctions are simulated to allow the trainee to experience these types of situations from all areas of the control room. According to voluntary standards retraining should include; 28/

(1) Plant startup and shutdown procedures;

(2) Normal plant operating conditions and procedures;

(3) Operational limitations, precautions and set points;

(4) Emergency plans and security procedures;

(5) Abnormal operating procedures;

(6) Emergency shutdown systems;

(7) Changes in equipment and operating procedures;

(8) General safety, first aid and radiation safety;

(9) Alarms and instrumentation; and

(10) Operation of selected auxiliary systems important to overall plant safety.

SIMULATOR TRAINING: PROMISES AND PROBLEMS

Simulator training is widely used in many industries where operators need realistic training with dangerous or expensive equipment. The Link trainer of the aviation industry is a good example. Simulators have been used to train operators in nuclear power ever since the start of the nuclear navy 29/ and are widely used by the nuclear utilities. As noted earlier, the NRC requires simulator training as a prerequisite for operator licensing.

28/ Standard for qualification and training of personnel for nuclear power plants; proposed American National Standard. LaGrange Park, Ill., American Nuclear Society. ANSI/ANS-3.1. Dec. 1979 S.S.I. p. 29.

29/ Early naval simulator training was given with a working naval reactor built into part of a replica submarine hull.

Sources of Simulator Training.-- A utility can choose between acquiring its own simulator and buying simulator training from commerical vendors. A list of such vendors appears in Appendix III. In most cases, utilities reportedly seek outside help from vendors since neither possess the qualifications and resources to handle the project alone. The vendor usually supplies the computer hardware, software, control panels, linkage between the control panels, mathematical modeling of the plant's dynamics, instructors, training of simulator personnel, and initial maintenance. The vendor relies on the utility to supply current information on plant operating characteristics as well as operating procedures. Unless the utility decides to build its own simulator, the training is done at the vendor's location which may be a distance from the utility's nuclear power plant.

Standards for Simulator Training.-- The NRC has not issued mandatory standards for simulator training. A voluntary standard, ANS 3.1, states:

> Candidates shall practice manipulating the controls of a plant as represented by an applicable simulator. As a minimum, the license candidate shall participate in training sessions that include all of the applicable plant manipulations identified in the section. Participation shall be in groups of no more than four people manipulating the controls or directing the activities of individuals during plant exercises. [30]

Qualifications for Simulator Vendors.-- The most important qualification that a vendor of simulator training can possess is the quality of its instructors. Instructors have to be throughly versed in plant operations in order to effectively teach their students. In order to be most effective they should meet all of the requirements for a Senior Reactor Operator and should either be licensed at the Reactor Operator level or as a minimum, have an approved certification at the Senior Reactor Operator level. This is particularly important for training programs at the requalification of operators attending simulation school or requalification training. These operators tend to distrust inexperienced instructors. 31/

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[30] Standard for Qualification and Training of Personnel for Nuclear Power Plants; Proposed American National Standard. La Grange, Ill.: American Nuclear Society. ANSI/ANS-3.1 Dec. 1979. p. 31.

Kinds of Simulators.-- There are three types of simulators: part-task, basic, and full-scope. Part-task simulators usually deal with one or a few major closely interacting reactor systems. The basic principle simulators usually include the most important parts of a total reactor system, with each is simulated in a crude approximation. Textbook formulas are typically used, rather than the actual design of a specific real- world system. Their main use is an introductory educational device rather than for acutal training. Full-scope simulators are the most useful of all. They contain simulations of significant, real plant systems so that the trainee/operator is placed in an environment that is practically indistinguishable from the real thing. The level of difficulty of tasks can be increased by using powerful computers.

Reasons for Using a Simulator.-- The reasons for using a simulator instead of a real system follow:

(1) A valuable part of any operations training program is the feel for a working system. Ideally, the simulator should be an accurate replica of the controls for a specific power plant. However, it is possible to use one which is dissimilar, if the proper objectives, methods and procedures are established and closely followed.

31/ For more information on simulators see the proceedings of the Third Symposium on the Training of Nuclear Facility Personnel (April 29-May 27, 1979) pp: 368-472.

(2) Use of a simulator permits operators to be drilled for responses to abnormal situations--malfunctions or emergencies that could not be allowed in real plant operations because of safety. If a trainee made a mistake in a real control room, the instructor would immediately step in to correct it for reasons of safety. A simulator, however, can enable an operator to see and attempt to deal with the consequence of an error. A lasting impression of proper emergency operating techniques can be created by practice under stress.

(3) A simulator can be immediately changed from one operating problem to another. This is invaluable for training. The inflexibility of a real plant would slow down training.

(4) Simulator training is a good way of correcting problems of operating errors or poor judgment and of assuring that they will not occur in practice.

Problems of Simulator Training.-- Whereas simulators offer benefits for effective training of reactor operators, there have been problems. These include:

(1) Difficulties when a simulator does not match the controls of a specific nuclear power plant. If the simulator is not a replica of the controls of a specific nuclear power plant, operators have to spend part of their training time learning the simulator before training can begin, thus decreasing the productivity of the training time. Emergency procedures learned at a dissimilar control center may require "translation" in time of crisis.

(2) Trainees may be informed in advance of the kind of situations to be simulated and thus anticipate them.

(3) Commerical suppliers may tend to emphasize what their simulators can do best rather than what the trainee of a particular utility needs most.

(4) Training at a place distant from the power plant puts limits on the time available and training to those occassions when an operator can be sent away for several days or more.

THE INDUSTRY'S RESPONSE TO THREE MILE ISLAND

With the inital investigations of the accident at Three Mile Island assigning some of the blame to the operators and their training, it is not surprising that part of the nuclear industry's response to the accident extended to training. The industry's most visible response was to establish three committees and organizations which are briefly described below. These included a Policy Committee formed by the Atomic Industrial Forum (AIF), the Nuclear Safety Analysis Center, (NSAC), formed by the Edison Electric Institute; and the Institute of Nuclear Power Operations (INPO) founded as an outgrowth of the AIF's Policy Committee.

THE ATOMIC INDUSTRIAL FORUM'S POLICY COMMITTEE

Soon after the accident at Three Mile Island, the Atomic Industrial Forum formed a Policy Committee with Byron Lee Jr. of Commonwealth Edison Company, as chairman. Its purpose was to consolidate the industry's response to lessons learned at Three Mile Island. The Policy Committee's membership included senior officials from four nuclear steam supply vendors, several architect-engineering firms that design nuclear plants, and a cross section of nuclear utilities. 32/

The work of the Policy Committee was assigned to subcommittees which drew upon involvement of both individuals and organizations. The subcommittees formed were the following: 33/

(1) Subcommittee on Operations.-- In meetings in June and July,1979 this subcommittee under Richard Eckert, senior Vice President of Public Service Gas and Electric Company concerned itself with the development of the Nuclear Operations Institute, which later became the Institute of Nuclear Power Operations (INPO).

32/ For a listing of AIF policy committee members see Appendix IV.

33/ Operations institute taking shape organizing committee sets goals. Nuclear Industry. August 1979: 26-28

(2) Subcommittee on Emergency Response Planning--This group was chaired by Warren Owen, Senior Vice President of Duke Power; it worked on refinements to the Nuclear Power Emergency Response Plan aimed at providing a framework within which each host utility can structure a specific recovery organization for each operating reactor.

(3) Subcommittee on Systems and Equipment-- Working closely with the NRC Lessons Learned Task Force, this group chaired by Clark Gibbs, director of nuclear activities for Middle South Services, Inc. prepared recommendations on containment, isolation, emergency power supplies, post accident hydrogen control, instrumentation to follow the accident and safety process systems classifications.

(4) Subcommittee on Post Accident Recovery-- This group made recommendations on plant auxilary systems that would be needed after an accident to keep a plant in a safe and decontaminated condition. Meeting under the direction of William Lindblad, Vice President of Portland General Electric Company, and exchanging notes with the NRC staff, the panel looked into the leakage control of systems outside containment design review of shielding liquid radwaste processing,pumping liquids and gases to containment, effluent release criteria, emergency power requirements and other issues.

(5) Subcommittee on Safety Analysis Considerations--This group paid particular attention to the single failure criterion and the distinction between its use in design and the development of emergency procedures and operator training. Other topics included failure modes and effects analyses, small break analysis, expanded scope of transient analyses, and safety research. Chairman of this panel is Ruble Thomas, Vice President of Nuclear Affairs with Southern Services Co.

(6) Subcommittee on Control Room Considerations-- Working with the NRC, this panel,chaired by Stephan Howell, Vice President of the Consumers Power Company, addressed a number of objectives. Among them are: involving the plant operator as an integral part of the proceess to avoid abnormal conditions, or to respond properly if they occur; validating critical information, providing system level alarms for critical systems to safety, and providing for suitable control room environment.

(7) Unresolved Generic Safety Issues-- The chairman of this subcommittee was John Ward, vice president of Sargent and Lundy, who is also chairman of the Forum's Committee on Reactor Licensing and Safety. This sub-committee maintains a continuing liaison with Stephen H. Hanuaer, assistant director of the NRC's Division of Systems Safety, who is also leading the NRC Task Force on Unresolved Safety Issues.

THE TMI AD HOC NUCLEAR OVERSIGHT COMMITTEE 34/

On April 11, 1979, at the initiative of the Board of Directors of the Edison Electric Institute, a TMI Ad Hoc Nuclear Oversight Committee was formed to coordinate the utilities response to Three Mile Island. Eight senior utility executives were chosen to serve on the Committee. Members included Floyd Lewis, Chairman (Middle South Utilities), Thomas Ayers (Commonwealth Edison), Lee Evert (Philadelphia Electric), William Lee (Duke Power), Frank Linder (Dairyland Power Cooperative), A.J. Pfister (Salt River Project), John Selby (Consumers Power), and Frank Warren (Portland General Electric).

An important function of the Oversight Committee was to direct and coordinate the many and diverse efforts that were underway within the industry. The Oversight Committee recieves input from all sectors of the nuclear industry, utilities, suppliers and trade associations.

One of the first actions of the Ad Hoc Oversight Committee was to request and authorize the Electric Power Research Institute to set up a Nuclear Safety Analysis Center (NSAC).

THE NUCLEAR SAFETY ANALYSIS CENTER (NSAC) 35/

A Nuclear Safety Analysis center was established at the Electric Power Research Institute (EPRI) in Palo Alto, California, but is independent of EPRI and has a separate industry supported budget. It's purpose was to carry out a detailed technical analysis of the events at TMI on March 28 and to interpret the lessons to be learned from them.

Related functions were to:

(1) Analyze the various failure modes encountered and evaluate their relative contributions to the overall event;

34/ Nuclear Safety Review Task Force Phase I Report. July 1979. 16 p.

35/ Nuclear Safety Analysis Center Industry Report. June 1979, No. 1. 4 p.

(2) Evaluate proposed technical fixes and modifications and recommend priorities of suggested responses;

(3) Survey and clarify the low level radiation effects upon the local population;

(4) Collect and exchange technical information related to the accident.

In addition, NSAC coordinated its evaluation with 60 different individual utilities with six utility owner's groups and with TMI related committees established by the Atomic Industrial Forum. NSAC interacts with the Nuclear Regulatory Commission and provided technical support to the Kemeny Commission.

NSAC is headed by Dr. Edwin L. Zebroski, head of the Systems and Materials Department of the Nuclear Power Division at EPRI. 36/ The organization is expected to have a full time staff of about 30 experienced professionals plus support staff. Ten nuclear experts from EPRI's Nuclear Power Division have been assigned to NSAC on a full time basis.

On July 28,1979, NSAC completed a detailed analysis of the TMI accident. 37/ The analysis included a second-by-second and minute-by-minute reconstruction of the events that took place at TMI over the 6 hour period until forced circulation cooling of the reactor core had been re-established.

During 1980 NSAC hopes to accomplish the following: 38/

(1) Significant Events-- An evaluation of significant events of U.S. reactor operating experience. This analysis includes both the engineering evaluation and probablistic analysis.

(2) What-If Studies--Studies are being conducted on what might have happened at TMI if different courses of action had been pursued or if different conditions had existed.

36/ For an organizational chart of NSAC see Appendix V.

37/ Report on the Accident at TMI (NSAC-1)

38/ Nuclear Safety Analysis Center Industry Report. Nov.-Dec. 1979. No. 5. p. 1-2.

(3) Generic Safety Issues-- Studies here are geared towards an identification and evaluation of generic safety issues with potential solutions. This group will coordinate related activities with INPO. They will also be responsible for looking into improvements in control room design.

(4) TMI Recovery and Support -- Continued support and assistance will be given to the GPU Corporation in the areas of reactor decontimination, rad waste processing storage and disposal R&D activities following re-entry into the TMI containment and problems related to the eventual restart of the plant.

INSTITUTE FOR NUCLEAR POWER OPERATIONS (INPO) 39/

An Institute for Nuclear Power Operations was established by the Atomic Industrial Forum's Policy Committee, Subcommittee on Operations in July 1979. INPO is dedicated to ensuring the high quality of operation in nuclear power plants. Its purposes are to establish industry wide benchmarks for excellence in operation of nucler power plants and to conduct independent evaluations to assist utilities in meeting these benchmarks. INPO is also working to establish educational and training requirements for operating personnel and will attempt to accredit training organizations. With respect to operator training, INPO staff will train reactor operator trainers and utility management rather than reactor operators themselves. 40/ The seven goals which the Institute hopes to accomplish are to:

(1) Promote a level of professionalism in nuclear power operations commensurate with the importance to the public of safe, reliable and economically efficient operations.

(2) Involve plant operating staffs in development of benchmarks and training systems in conduct of the operations evaluations;

(3) Use the best available techniques and methods to develop operating and training practices and the human factors aspects of design and operation.

39/ Discussion paper on the Establishment of an Institute of nuclear power operations. August 1979: 4 p.

40/ Ann MacLachlan. INPO to be based in Atlanta; Operations start next month. Energy Daily. Nov. 15, 1979. p. 2-3

(4) Utilize independent professional advice and counsel towards accomplishing objectives.

(5) Support and improve existing practices and training systems wherever possible, rather than supplant them;

(6) Help the utilities to help themselves rather than preempt their management responsibilities;

(7) Encourage excellance

To accomplish this, INPO plans to:

(1) Establish industrywide benchmarks for excellence in the managment and operation of nuclear power plants;

(2) Conduct independent evaluations to determine what benchmarks are being met;

(3) Review nuclear power operating experiences for analysis and feedback to the utilities; incorporate lessons learned into training programs; coordinate information reporting and analysis with other organizations;

(4) Establish educational and training requirements for operations and maintenance personnel and develop screening and performance measurement systems;

(5) Accredit training programs and instructors;

(6) Conduct seminars and generic training for various utility employees including instructors, utility executives and upper management to ensure quality in the operation of nuclear power programs;

(7) Perform studies and analysis to support development of criteria for operations for training and for the human factor aspects of design and operation.

(8) Provide emergency preparedness coordination for the nuclear utility industry;

(9) Exchange information and experience with operators of nuclear power plants in other countries.

Institute Organization.-- INPO consists of a Board of Directors, an Advisory Council, an Industry Review Structure, a President, and five divisions. 41/ The Board of Directors is responsible for setting the Institute

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41/ For an organizational chart of INPO see Appendix VI.

policies and directions. It is composed of a chairman and elected members from member utilities. William Lee, president of Duke Power is the chairman. Vice Admiral Eugene P. Wilkinson (U.S.N. Ret.) is the President of INPO. The initial board members include, John Selby, president and chairman of the Consumers Power Company; Donald Jordon, president of Houston Lighting and Power Company; James O'Connor, president of Commonwealth Edison Company; William Gould, president of Southern California Edison Company; Lee Sillin, Chairman and president of Northeast Utilities; Jack Pfister, general manager of the SALT River Project; William Walbridge, general manager of the Sacramento Municipal Utility District; Frank Linder, assistant general manager of the Sacramento Municipal Utility District; Glenn Reed, manager of Wisconsin Electric Power Company's Point Beach nuclear station; and Carl Andognini, plant supervisor at Boston Electric Company's Pilgrim nuclear station.

The Advisory Council is responsible for review of the Institute's programs and advises the Board of Directors. The Council is composed of distinguished persons in areas related to the Institute's objectives. For a listing of members, see Appendix VII.

The Institute estimates that its work will eventually require a staff of about 200. The functions of each division are described below.

Training and Education Division.-- Of all INPO's divisions this one is the most closely associated with operator training. Its assigned general functions are to:

(1) Review lesson plans and training materials for reactor operators. Existing approaches will be upgraded if needed.

(2) Accredit instruction systems for nuclear power operations technology. Certify instructors; assist in their training and the development of teaching skills as necessary.

(3) Assist in utility planning to meet manpower needs.

(4) Conduct workshops, seminars, and training programs as needed.

(5) Periodically publish information of interest to nuclear power operations and training staffs.

The activities of the Training and Education Division include the following:

(1) Relations with regulatory and government agencies on public safety;

(2) Crisis management and communication with the public and the regulatory agencies;

(3) Upgrading of training and abilities of operators to handle off-normal events;

(4) Increasing the understanding of plant systems and operations by supervisors and engineering support staff;

(5) Develop training programs for supervisors;

(6) Development of training specifications and performance standards for skilled workers and for technicans involved in plant maintenance and operations support.

Criteria Development and Analysis Division.-- This INPO division develops benchmarks and guidelines for use in nuclear power operations, identifies training needs, and develops and evaluates training techniques. Its goals include the following:

(1) Synthesis of information on present practices, obtained from the Training Division;

(2) Identification, monitoring and evaluation of operation problems;

(3) Coordination of data bases and events evaluations with related work done by NSAC, EPRI, and other organizations;

(4) Studies and analyses including human factor studies, sponsored studies in direct support of operations, and comparisions with practice in other countries;

(5) Review of proposed guidelines with the Industry Review Structure.

This division provides liaison with the architect-engineers and vendor organizations to ensure their participation in Institute activities.

In order to support criteria development studies and analyses, INPO projects that studies may be done on:

(1) Adequacy of training simulator models and techniques of simulator use. Development of performance measures and evaluation systems;

(2) Effectiveness of advanced instructional methods such as computer aided instruction and part-task simulators;

(3) Psychological and physiological studies in areas such as shift rotation attentiveness and stress;

(4) Communication techniques and procedures;

(5) Control room alarm presentation, control concepts, and information processing and display;

(6) Methods for effective use of operating and casualty procedures;

(7) Detailed human factors analysis of generic operating and casualty procedures

(8) Stress response testing for screening and development;

(9) Organizational behavior and motivation.

Evaluation and Assistance Division.-- The objective of this INPO division is to identify and publish the best nuclear plant operating practices and to inform and assist utilities that might adopt these practices. Six evaluation teams consisting of four to six members of the staff comprise this division. Evaluations are reportedly being made on a plant by plant basis and include:

(1) Management and organization;

(2) Plant operating practices;

(3) Training and qualifications;

(4) Technological support;

(5) Maintenance practices and material condition;

(6) Human factors aspects of design, arrangements and practices;

(7) Radiological controls;

(8) Emergency preparedness;

(9) Procedures, documentation and administration;

(10) In-house audit and quality assurance practices.

Emergency Preparedness Division.-- This INPO division is working to establish and maintain a listing of those experts in various fields who could be available if a utility experiences an emergency. They are also compiling a list of emergency equipment, where it is located, and whom to contact concerning availabilty.

Administration Division.-- This INPO division provides the internal support, travel arrangements, personnel management and financial functions of the Institute.

Accomplishments by INPO, To Date.--A rigorous training program for shift technical advisers was proposed by INPO in April 1980. 42/ The NRC earlier had required that a shift technical advisor be on site at each operating utility by January 1,1980. INPO sought to help meet the problem faced by utilities in how to train these advisors, not by doing the actual training but by providing a curriculum. This curriculum calls for proficiency in a host of academic and practical disciplines.

The recommended academic disciplines include mathematics, reactor theory, reactor chemistry, nuclear materials, thermal sciences, electrical sciences, nuclear instrumentation and controls, and health physics. On the operating side are plant specific reactor technology, management skills, plant systems, administrative control,general operating procedures, transient and accident analysis and emergency procedures.

42/ Nuclear Power Plant Shift Technical Advisor; Recommendations for Position Description, Qualifications, Education and Training. The Institute of Nuclear Power Operations. Revision 0. April 30, 1980. p. 19

INVESTIGATIONS OF THE ACCIDENT AT THREE MILE ISLAND

Two separate investigations were established by the U.S. Government, one the President's Commission on the Accident at Three Mile Island (The Kemeny Commission); the other, the U.S. Nuclear Regulatory Commission Special Inquiry Group (The Rogovin Report). In addition, the supplier of the reactor at Three Mile Island established a Technical Review Committee. Each investigation gave some attention to operator training.

THE KEMENY COMMISSION 43/

The Kemeny Commission's conclusions included the following with respect to training of nuclear power plant operators: 44/

(1) Training of Met Ed operators and supervisors was inadequate and contributed significantly to the seriousness of the accident. The training program gave insufficient emphasis to principles of reactor safety.

(2) The TMI training program conformed to the NRC standard of training. Moreover, TMI operator license candidates had higher scores than the national average on NRC licensing examinations and operating tests. Nevertheless, the training of the operators proved to be inadequate for responding to the accident.

(3) Met Ed had primary responsibility for the training of operators. The quality of the training program at TMI was low.

  a. The training program was quantitatively and qualitatively understaffed as well as conceptually weak; emphasis was not given to fundamental understanding of the reactor and little time was devoted to instruction in the biological hazards of radiation. The content was left to the instructors who had no greater formal education qualifications than those of their students.

43/ President's Commission on the Accident at Three Mile Island, John Kemeny, Chairman. Report of the Commission; The Need for Change: The Legacy of TMI. Washington D.C., U.S. Govt. Print. Off., 1979; p. 201 (Kemeny Report)

44/ Ibid. p. 49-50.

b. TMI-2's station manager, unit superintendent and supervisor of operations were not involved in operator training.

c. With NRC approval, the unit superintendent and the station manager at TMI were only required to acquire the experience and training necessary to be examined for a senior reactor operator license but were not required to hold such a license.

d. Although auxiliary operators performed tasks that could affect reactor power level or involve the handling of radioactive materials, there was no formally defined training program for them.

e. Met Ed did not request waivers from employees with naval reactor experience to allow examination of their Naval records.

(4) TMI contracted with B&W to carry out a portion of the TMI operator training. B&W performed only those functions specifically required under the agreement.

a. There was little interaction in B&W between those who conducted training and those responsible for nuclear plant design. Course content and conduct were made up by the B&W training department entirely on its own. There were no formal syllabi or training manuals.

b. The simulator at B&W was a key tool in the training of operators for multiple-failure accidents. Indeed, the B&W simulator was not prior to March 28, programmed to reproduce the conditions that confronted the operators during the accident. It was unable to simulate increasing pressurizer level at the same time that reactor coolant pressure was dropping.

In addition to its Summary Report, the Kemeny Commission also published four supporting volumes of staff reports. One, entitled The Role of the Managing Utility and Its Suppliers 45/ briefly mentioned operator training. It stated,

> The B&W training department in Lynchburg used as a basis for training a blend of B&W's own simulator procedures, and the procedures of the utility from which the operators came. However, B&W was not on Met Ed's distribution list for procedure revisions at the time of the accident, although it asked to be put on the list shortly thereafter. 46/

45/ President's Commission on the Accident at Three Mile Island, John Kemeny, Chairman. Report of the Commission; The Role of the Managing Utility and Its Suppliers. Washington D.C.: U.S. Govt. Print. Off., 1979; p. 145

46/ Ibid. p. 88.

The report also states that at the time of TMI, B&W simulator procedures were also being upgraded under the direction of B&W's lead instructor, John Lind. Lind had been employing utility procedures as guidelines for the upgrading of simulator procedures. 47/

BABCOCK AND WILCOX (B&W) RESPONSE TO TMI

Shortly after the accident B&W established a technical review committee to assess its role in the accident. 48/ The task of the review committee was three-fold: 49/

(1) To review the technical aspects of the TMI-2 occurence;

(2) To develop recommendations and engineering programs to improve plant safety and reliability, with emphasis on the nuclear steam system and the interaction of that system with the balance of plant; and

(3) To assess the impact of the TMI-2 occurence and resulting changes in NRC regulations on B&W technical programs, procedures and standards.

With reference to operator training, the committee in tackling the last task was charged with considering the relationships among B&W's engineering, service, training, licensing, human engineering and research and development program. In a draft which was written by the technical

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47/ Kemeny Report op cit. p. 88.

48/ The group was headed by B&W's manager of product development, Russell M. Ball. It included Charles Welch, laboratory manager at Alliance Research Center; Robert W. Kubik, formerly manager of advanced controls and experimental physics laboratory at B&W's Lynchburg Research Center; James Taylor, B&W's manager of licensing; Don W. Montgomery, B&W's manager of advance reactor development; Doug Cannon, Bailey Controls Systems; and Allen Womack, manager of the plant design section in the B&W Engineering Department.

49/ President's Commission on the Accident at Three Mile Island, John Kemeny, Chairman. Report of the Commission; The Role of the Managing Utility and Its Suppliers. Washington, D.C., October 1979. p. 139

review committee and reviewed by the TMI Commission staff in mid-October 1979, the committee concluded:

> Operators were apparently unable to understand and interpert plant condition from available control room information. They had no "mental image" of the nuclear steam supply system characteristics when boiling occured in the primary look. Their analysis of the system conditions led to action decisions which caused the incident to result in core damage. 50/

One of its six recommendations touched on training. It was to provide for enhanced basic fundamental knowledge and understanding to operator through training. 51/

Other parts of the B&W findings and recommendations also addressed operator training, specifically, ways to improve operator effectiveness for all aspects of plant operation under both normal and abnormal conditions. The report called for developing ways to measure operator effectiveness, including measures of relative merit and probability of error for various circumstances; and developing teaching methods to convey an appropriate understanding or perception of the nuclear steam system. 52/

THE ROGOVIN REPORT

Shortly after the accident, the Nuclear Regulatory Commission instituted a Special Inquiry Group (SIG) headed by Mitchell Rogovin. The principal objectives of the inquiry were to determine what happened and why, to assess the actions of utility and NRC personnel before and during the accident, and to identify deficiencies in the system and areas where further investigations might be warranted. It also examined

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50/ Kemeny Report Ibid. p. 140.

51/ Ibid. p. 141.

52/ Ibid. p. 143-144.

some aspects of operator training. The Rogovin Report was issued in December 1979 in two volumes in four parts. 53/

Concerning operator training, the report said: 54/

> Some previous analyses of the Three Mile Island accident have been read to attribute it to "operator error". We reject this conclusion as being incomplete. While there is no question that operators erred when they interfered with the automatic operation of the high pressure injection (HPI) system even though conditions that had initiated the system(low pressure) persisted, we believe there were a number of important factors not within the operators' control that contributed to this human failure. These included inadequate training, poor operator procedures, a lack of diagnostic skill on the part of the entire site management group, misleading instrumentation, plant deficiencies, and poor control room design. For these failings the industry and the NRC must share responsibility with Met Ed.

The group concluded that the operators on duty had not recieved training adequate to ensure that they would be able to recognize and respond to a serious accident during the first hour or two after it occured. 55/ Based on its investigations, the Special Inquiry Group, said further: "there is a clear need to restructure and improve operator training, and to upgrade sustantially the requirements for technical qualifications of onsite supervisors and management, up through the plant or unit superintendent." 56/

53/ U.S. Nuclear Regulatory Commission. Special Inquiry Group., Mitchell Rogovin, Director. Three Mile Island; A Report to the Commissioners and to the Public. Washington D.C. 1980, 2 vols. NUREG/CR-1250. (Rogovin Report)

54/ Ibid. Vol. I. p. 102.

55/ Ibid. Vol. I. p. 103.

56/ Ibid. Vol. I. p. 103.

Specific Mention of Operator Training--With respect to the NRC's licensing of reactor operators and senior operators, and its written and oral examinations the inquiry group concluded that " these examinations do not even measure operator ability accurately, much less,ensure that an operator has the knowledge or competence to operate a reactor safely when something unexpected occurs. Only adequate training can do that." 57/

A weakness of the current program, they wrote, was the "fact that the largest portion of operator training is reading and classroom training. Therefore, a problem crucial to the Three Mile Island Accident was that operators are trained primarily for normal power operations and for startup and shutdown of the plant, not for accidents". 58/

Because of the lack of personnel within the NRC with the proper background and experience to study operator selection and training, the SIG contracted for outside assistance from the Essex Corporation. 59/ On the basis of its evaluation of the pre-accident training program, Essex concluded that the TMI program was deficient in the following respects: 60/

1. It was not directed at the skills and knowledge required of the operators to satisfy job requirements.
2. Too little simulation was provided and where it was used it was misused.

57/ Ibid. Rogovin Report, Vol. I. p. 103

58/ Ibid. Vol. I. p. 103.

59/ The Essex Corp., "Human Factors Evaluation of Control Room Design and Operator Performance at Three Mile Island-2". NUREG/CR-1270, Vol.1: Final Report, December 1979.

60/ Op. cit. Vol. II. p. 604-605.

3. It failed to provide the operators with the skills they needed in the accident; e.g. skills in developing a hypothesis and acquistion of feedback data to verify the hypothesis.

4. It failed to provide for measurement of operator capability.

5. It provided no instruction for the instructors on how to reinforce lesson objectives or how to assist trainees in understanding the system.

6. It took an archaic approach to learning, that no applications of instructional technology were included in the program.

7. It was not closely associated with procedures used by the operators, and no guidance was provided in what to do if procedures do not apply.

8. It did not provide for formal updating and upgrading of training methods, materials and content.

9. It failed to establish in the crew the readiness necessary for effective and efficient performance.

The Essex coroporation summarized its conclusions: 61/

> Operators were exposed to training material but they certaintly were not trained. They were exposed to simulators for the purpose of developing plant operation skills, but they were not skilled in the important skill areas of diagnosing, hypothesis formation and control technique. They were deluged with detail yet they did not understand what was happening. The accident at TMI-2 on the 28th of March 1979, reflects a training disaster.
>
> The overall problem with the TMI training is the same problem with information display in the TMI-2 control room application of an approach which inundates the operator with information and requires him to expend the effort to determine what is meaningful.

Simulator Training.-- Before the TMI accident, The Rogovin Report states, "the simulator training that was available to Met Ed operators was not dissimilar to that throughout the country. However, it was rarely used to require them to respond to simulated accidents involving more than a single failure." 62/ Nor "were operators often required to diagnose the causes

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61/ Ibid. Vol. II. pp. 604-605.

62/ Ibid. Vol. I. p. 104.

of failures given to them on the simulator; often they were told in advance what failure had been programmed for them to respond to." 63/

What the accident made clear, " is that even senior operator training is insufficient to give operators a basic appreciation of the way safety systems interact and of what phenomena they can expect to see on their instruments from conditions that are not normal in their previous experience." 64/

These problems are not unique to Metropolitan Edison, the Rogovin Report points out. Although, "Met Ed's training program was in some respects deficient, it appears that Met Ed afforded its operators training that, was typical of the industry and, in certain respects was above average." 65/

Simulator Training After the Accident-- After the accident, the Rogovin report states, one Met Ed offical, in coordination with B&W, iniated a simulator training program that illustrates the direction they believe operator training should take. The simulator was programmed to deal both with startups or routine operations and also with various accident sequences. Also, instead of dividing a crew of operators betweeen study amd simulation, the entire crew was taken through a number of accident sequences and graded on their responses as a team, not as individuals. Some of these accident sequences were not limited to a single failure, but were multiple failure accidents. In addition, the accident simulations were not the customary short ones, but rather long ones, with goal of the operators to limit damage.

63/ Ibid. Vol. I. p. 104.

64/ Ibid. Vol. I.. p. 104.

65/ Ibid. Vol. I. p. 104.

The Rogovin report concluded that more of this type of training is needed. 66/ There are however difficulties in expanding it. "One is hardware related; many plants do not have simulators that closely replicate their control rooms. The second difficulty is that the control room does not have the feel or play of the TMI control room which is larger, more confusing and less organized." 67/

They recommend that,"the NRC assume a direct role in the training of operators, promulgate criteria for facilities and instructors, and review and approve the curriculum for the initial and recurring training programs and retain its present authority to test and license operators and supervisory operators." 68/

66/ Rogovin Report. op. cit. p. 105.

67/ Ibid. p. 105.

68/ Ibid. p. 105.

APPENDIX I

AMERICAN NUCLEAR SOCIETY STANDARDS SPONSORED N COMMITTEES

The ANS Sponsored N Committee include:

(1) Nuclear Criticality Safety-- Standards for determining the potential for nuclear criticality of fissile material outside reactors, for the prevention of accidential criticality and for coping with accidents should they occur.

(2) Research Reactors, Reactor Physics and Radiation Shielding--Standards for the location, design, construction, operation and maintenance of all nuclear reactors for training and research, both as mechanisms for investigating reactors per se and as sources of radiation, excluding reactors designed for the production of electrical energy; standards for the location, design, construction, operation and maintenance of critical facilities; standards for calculational methods and computer codes for for use in nuclear-reactor and reactor physics calculations, including shielding. Input into calculations and codes, such as nuclear cross sections are included here.

(3) Nuclear Design Criteria--Nuclear aspects of design criteria for nuclear power generating stations.

(4) Nonradiological Environmental Effects-- Standards for the protection of individuals and the environment from the nonradiological impact of nuclear facilities.

(5) Radioactive Waste Management-- Definition of waste categories, general criteria for waste management and standards

Source: Compilation of the American Nuclear Society Standards (1971). The American Nuclear Society. LaGrange Park, Ill. p. 3.

APPENDIX II

COMMERCIAL SUPPLIERS OF REACTOR OPERATOR TRAINING IN THE UNITED STATES

Allied-General Nuclear Services
P.O. Box 847
Barnwell, S.C. 29812
803/259-1711

Babcock & Wilcox Co., The
161 E. 42nd Street
New York, NY 10017 USA
212/687-6700

Black & Veatch International
P.O. Box 8405
Kansas City, MO 64114 USA
913/967-2000
Telex: 42523

Chem-Nuclear Systems, Inc
One Greystone West
240 Stonehedge Drive
Columbia, SC 29210 USA
803/799-2190

Combustion Engineering, Inc.
1000 Prospect Hill Road
Windsor, Conn. 06095 USA
203/688-1911
Telex: 099297

Crane Inspection & Certification Bureau
(Div. of Superintendence Company Inc.)
7200 Lake Ellenor Drive
Suite 245
Orlando, Fla. 32809 USA
305/855-1511
Telex: 56-6548

Ebasco Services, Inc.
Two Rector Street
New York, NY 10006 USA
212/785-2200

EDS Nuclear Inc.,
220 Montgomery Street
San Francisco, CA 94104 USA
415/544-8000
TWX: 910-372-61000 Eds Sfo.

Energy Inc.,
P.O. Box 736
Idaho Falls, ID 83401 USA
208/524-1000
TWX: 910-978-5979

Energy Technology, Inc.
1440 Phoenixville Pike
West Chester, PA 19380 USA
215/647-6810
TWX: 510-668-8996

Exxon Nuclear Co.,
777 106th Avenue N.E.
Bellevue, Wash., 98004 USA
206/453-4300

General Atomic Co.
(Business Development Div.)
P.O. Box 81608
San Diego, CA 92138
714/455-4263

General Electric Company
(Nuclear Energy Group)
175 Curtner Avenue
San Jose, CA 95125 USA
408/925-6588
Telex: 357448

Gibbs & Hill
393 Seventh Avenue
New York, NY 10001 USA
212/760-5012
Telex: 12730

Industrial Training Crop.
14616 Southlawn Lane
Rockville, MD 20850 USA
301/279-2527

Miller, Tom W.,
1124 Franeim Road
Louisville, KY 40214 USA
502/367 2454

National Nuclear Corp.
3150 Spring Street
Redwood City, CA 94063 USA
415/364-2880
Telex: 910-378-5997

Nuclear Energy Services, Inc.
Shelter Rock Road
Danbury, Conn. 06810 USA
203/748-3581
Telex: 710-456-0392 Sperry Prod.

Nuclear Science And Technology Facility
Rotary Road, State University Of
New York at Buffalo
Buffalo, NY 14214 USA
716/831-2826

Nuclear Services Corp.
1700 Dell Avenue
Campbell, Ca 95008 USA
408/466-2500

Nuclear Startup Services, Inc.
5837 Echo Ridge
Stevensville, MI 49127 USA
616/429-7905

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OMNIDATA, Inc
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Singer Co., The
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Source: International Buyers Guide, Issue: Nuclear Energy International, March Supplement, 1980.

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Central Scientific Co.
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Chemtrol Corporation
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Control Technology co.
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Source: International Buyers Guide, Issue: Nuclear Energy International, March Supplement, 1980.

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Source: U.S. Congress. House. Committee on Science and Technology. Subcommittee on Energy Research and Production. Plans for Improved Safety of Nuclear Power Plants Following Three Mile Island Accident. 96th Cong. 1st Session. September 19, 1979, Washington, U.S. Govt. Print. Off., 1980; pp. 192-207.

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APPENDIX V

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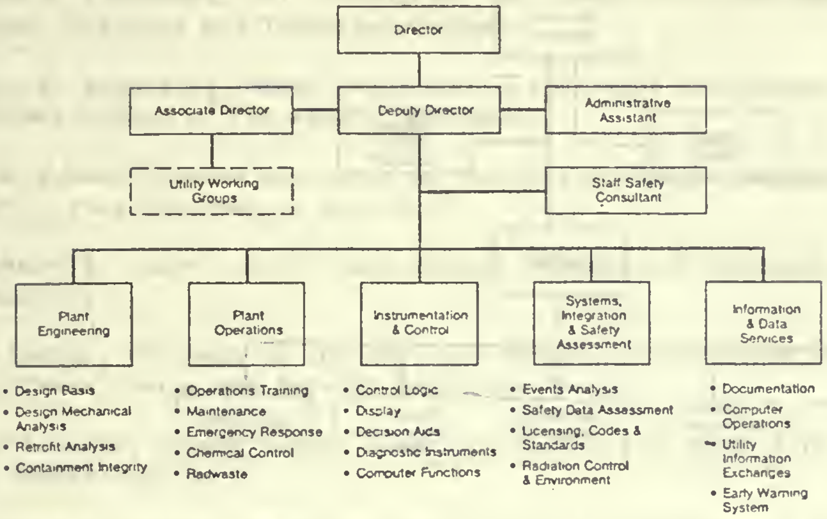
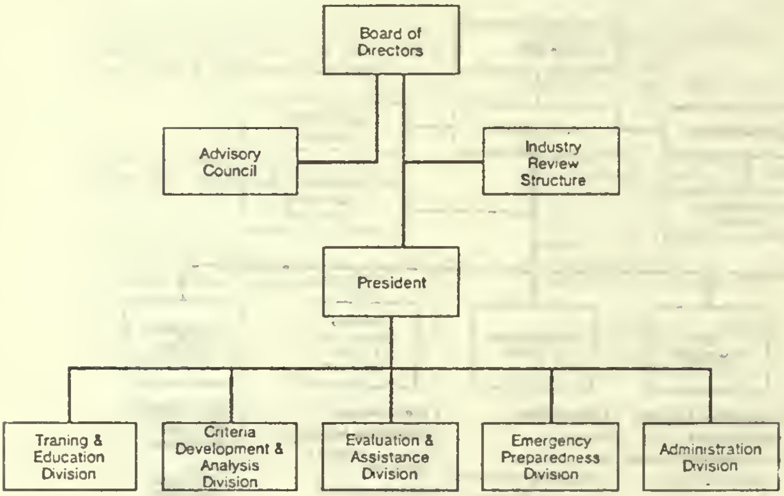


Source: U.S. Congress. House. Committee on Science and Technology. Subcommittee on Energy Research and Production. Plans for Improved Safety of Nuclear Power Plants Following the Three Mile Island Accident. Washington, U.S. Govt. Print. Off., 1979: 22.

APPENDIX VI

Institute of Nuclear Power Operations Staff Structure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Source: U.S. Congress. House. Committee on Science and Technology. Subcommittee on Energy Research and Production. Plans for Improved Safety of Nuclear Power Plants Following the Three Mile Island Accident. Washington, U.S. Govt. Print. Off., 1979: 27.

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John R. Hamann, former president of the Detroit Edison Company and currently vice chairman of the board

Dr. Edward R. Jones, chief human factors engineer at McDonnel Douglass Corporation;

Laura Keever, chairman of the Advisory Committee on Nuclear Energy of the Texas Energy and Natural Resources Council;

Jerome Lederer, former safety director for National Aeronautics and Space Administration;

Dr. Harold W. Lewis, former chairman of the Risk Assessment Review Group of the NRC currently a member of the Physics Department of the University of California, Santa Barbara;

Dr. Thomas Pigford, professor of nuclear engineering at the University of California, Berkley and a former member of the Kemeny Commission;

Samuel R. Ross, supervising engineer with R.W. Beck and Associates;

Dr. Robert C. Seamans Jr., Chairman of the Department of Engineering at the Massachusetts Institute of Technology;

Dr. John A. Swartout, retired vice president of Union Carbide Corporation, currently chairman of the Utilities Scientific Advisory Council of the Nuclear Safety Analysis Center and;

Dr. M. Gordon, chairman of the Department of Geography and Environmental Engineering at Johns Hopkins University;

Source: INPO White Paper, Feb. 13, 1980

APPENDIX VIII

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Part III

Appendices

Appendix A

Employment-Related Standards for Nuclear Power Reactor Operators, Airline Pilots, and Air Traffic Controllers

By

William G. Whittaker, Congressional Research Service, Library of Congress

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Congressional Research Service
The Library of Congress

Washington, D.C. 20540

April 16, 1980

TO : Nuclear Regulation Subcommittee
Senate Environment and Public Works Committee
Attention: Mr. Paul Leventhal

FROM : William G. Whittaker
Analyst in Labor Economics
Economics Division

SUBJECT: Employment-Related Standards for Nuclear Power Reactor Operators, Airline Pilots and Air Traffic Controllers

As you requested, we have been in contact, informally, with the appropriate Federal agencies in an effort to secure data concerning employment profiles of nuclear power reactor operators, airline pilots and air traffic controllers.

During our conversations with agency personnel, several things became clear.

First. Although there was a general desire to be helpful voiced by the spokespersons for the several agencies and related groups, there was also some reluctance to be pinned down to specific patterns. Often, someone would suggest that standards or guidelines were in the process of being revised (or, that revisions were contemplated). There would seem to be some fluidity in these matters; perhaps, some variation between formal policy and field practice, within bounds.

Second. Comparisons are extremely difficult to make. There are substantive differences between the duties of the several crafts (pilots, air traffic controller and nuclear powerplant operator). Further, within each of these crafts, there are variations in grade and level which, as well, appear to entail the application of differing levels of preparation, responsibility, stress, renumeration, etc. Although there may be certain similarities between these general crafts in that a mistake can have dire consequences (as could a mistake on the part of a physician or pharmacist), the differences may be even greater than the things shared in common. A comparison may not be especially useful while it may even provoke some distortion or imbalance if too narrowly drawn.

Third. For each of these categories of workers, some pre-employment testing and/or training appears to be prescribed. There would seem to be no practical way for the layman, short of an extended investigation (and then, with no real certainty), to evaluate the quality of the training received or the effectiveness of the tests actually administered. Enclosed are comments from Benjamin Shimberg, et al., Occupational Licensing: Practices and Policies (Washington, 1973), in which some critical questions are raised concerning the value of testing for licensing purposes.

There are often options for the substitution of experience for formal training. Again, there is raised the issue of quality assessment -- both for training and for experience. How often is such substitution made? Is experience more nearly desireable than training? It might be useful to have a statistical survey of employment patterns and practices for each of these craft categories. What have been the work histories, for example, of airline pilots? Are psychological tests administered to pilots, nuclear power facility operators, etc., and do such tests, if administered, have any particular validity? Are such tests, of whatever sort, comparable within the craft and for similar high-stress, high technology occupations?

Fourth. Generally, air traffic controllers are Federal employees, working directly for the Federal Aviation Administration. Pilots work for a wide range of private and public firms and agencies. Nuclear power facility operators may work for public agencies, but, as often, they are employed by utilities and private power interests. While there would seem to be some general requirements for licensing established through public regulation, the various firms (notably, the different airlines and utilities) may have their own standards, training programs, etc., and these may be different from and, perhaps, higher or more strict than those which are publically mandated.

On the several pages which follow, we have attempted, through a review of readily available materials, to sort out certain comments concerning the three crafts. We do not suggest that the information may be really comparable for each craft. Some of the material has been taken from the Code of Federal Regulation; other data, from agency manuals or from craft surveys. The detail of the several sources is not necessarily similar. The result may be something of a distortion, flowing from the fundamental inadequacy of the data on hand and the differing manner in which each source has presented its information. Thus, the comparison, here, is fragmentary, selective and incomplete.

Sources for the materials in the side-by-side comparison are indicated by numbers corresponding to the sources listed below. Whenever underscoring appears, it has been added by CRS for purposes of emphasis unless otherwise noted. Where there blank areas, no data was provided in the sources checked.

(1) United States Civil Service Commission, Qualification Standards Air Traffic Control Series, GS-2152, February 1976.

(2) United States Department of Commerce, National Technical Information Service, PB 255-664, A Guide for the Licensing of Facility Operators Including Senior Operators, Nuclear Regulatory Commission, July 1976.

(3) United States Department of Labor, Occupational Outlook Handbook, 1980-1981. Notes from galley proof.

(4) United States Code of Federal Regulation, Title 14, Aeronautics and Space, Chapter 1, Federal Aviation Administration.

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COMPARATIVE SUMMARY OF ELEMENTS INVOLVED IN THE TRAINING, EMPLOYMENT AND WORKING CONDITIONS OF AIR TRAFFIC CONTROLLERS, PILOTS AND NUCLEAR POWER REACTOR OPERATORS

	AIR TRAFFIC CONTROLLERS	PILOTS	NUCLEAR POWER REACTORS OPERATORS
GENERAL EMPLOYMENT DATA	"About 21,000 persons worked as air traffic controllers in 1978, mostly at major airport and air route traffic control centers located near large cities." (3) "Almost all [21,000 persons in 1978] were employed by the Federal Aviation Administration (FAA)." (3)	"About 76,000 civilian pilots worked full-time in 1978." (3) Of about 76,000 civilian pilots in the United States, it is noted: "About one-half worked for the airlines. Many of the others worked as flight instructors at local airports or for large businesses that use their own airplanes to fly company cargo and executives. Some pilots flew small planes for air taxi companies, usually flying passengers to or from lightly traveled airports not serviced by the airlines. Others worked for a variety of businesses performing tasks such as crop dusting, inspecting pipelines or conducting sightseeing trips. Federal, State and local governments also employed pilots." (3)	"About 17,500 workers operated and maintained nuclear reactors in 1978. Nuclear power stations employ reactor operators; mechanical, electrical, and electronic engineers; instrument and electronic technicians and radiation monitors. Machinery and instrument repairers, electricians, and pipefitters maintain and repair the reators." (3) Generally, nuclear power reactor operators are employed by utility firms or by Federal agencies.

	AIR TRAFFIC CONTROLLERS (cont.)	PILOTS (cont.)	NUCLEAR POWER REACTORS OPERATORS (cont.)
WORKING CONDITIONS: GENERAL	"Controllers work a basic 40-hour week; however, they may work additional hours for which they receive overtime pay or equal time off. Because control towers and centers must be operated 24 hours a day, 7 days a week, controllers rotate night and weekend shifts. "Air traffic controllers sometimes work under great stress. They must keep track of several planes at the same time and make certain all pilots received correct instructions." (3)	"By law, airline pilots cannot fly more than 85 hours a month. Most airline pilots actually fly less than 70 hours a month and, although they have additional nonflying duty hours, usually only work 16 days a month." "Airlines operate flights at hours of the day and night, so work schedules often are irregular. Pilots who have little seniority may be assigned night or early morning flights. (3)	
AGE CRITERIA	Applicants for entry-level air traffic controller positions must be less than 31 years-of-age. "Under the Authority of Public Law 92-297, a maximum age limit has been established for positions in the Terminal and Center Specializations in the Department of Transportation. Applicants who have reached their 31st birthday are ineligible for entry into positions in these specializations only. The maximum age limit, which may not be waived, does not apply to positions in the station specialization." (1)	Age requirements vary with the type of license held, the type of work a pilot performs. For a commerical pilot's license, applicants must be 18 years old and have at least 250 hours of flight experience. For an airline transport pilot's license (a requirement for "captains"), one "must be at least 23 years old and have a minimum of 1,500 hours of flying experience including night and instrument flying." (3)	

	AIR TRAFFIC CONTROLLERS (cont.)	PILOTS (cont.)	NUCLEAR POWER REACTORS OPERATORS (cont.)
PRE-EMPLOYMENT EXPERIENCE	The Civil Service Commission (now OPM) lists both general and specialized experience requirements for air traffic controllers. General experience: "Progressively responsible experience in administrative, technical, or other work which demonstrated potential for learning and performing air traffic control work." Special experience: "Experience in a military or civilian air traffic facility which demonstrated possession of knowledges, skills, and abilities required to perform the level of work of the specialization for which application is made." (1) ". . . applicants must have 3 years of general work experience or 4 years of college, or a combination of both." (3)	"Flying can be learned in military or civilian flying schools. Either kind of training satisfies the flight experience requirements for licensing, but persons serving in the Armed Forces have the opportunity to gain the substantial experience on jet aircraft that is preferred by airlines and many businesses. "Pilots hired by airlines must be high school graduates; however, most airlines require 2 years of college and prefer to hire college graduates." (3)	"Nuclear power reactor operators need a basic understanding of reactor theory and a working knowledge of reactor controls. Most operator trainees are high school graduates. Some receive specialized training, through technical schools or training programs in the military service. Many trainees are selected from conventional power plant personnel who have experience operating boilers, turbines, or electrical machinery." (3)
PRE-EMPLOYMENT PHYSICAL EXAMINATION	"Applicants must be in excellent health and have vision correctable to 20/30." (3)	To qualify for a commerical pilot's license, applicants "must pass a strict physical examination to make sure that they are in good health and have 20/20 vision with or without glasses, good hearing, and no	"Requirements for the approval of application. "An application for a license pursuant to the regulations in this part will be approved if the Commission finds that: "(a) The physical conditions and the general

	AIR TRAFFIC CONTROLLERS (cont.)	PILOTS (cont.)	NUCLEAR POWER REACTORS OPERATORS (cont.)
PRE-EMPLOYMENT PHYSICAL EXAMINATION (cont.)		physical handicaps that could impair their performance. (3)	health of the applicant are not such as might cause operational errors endangering public health and safety. "(1) Epilepsy, insanity, diabetes, hypertension, cardiac disease, fainting spells, defective hearing or vision or any other physical or mental condition which might cause impaired judgment or motor coordination may constitute sufficient cause for denial of an application. "(2) If an applicant's vision, hearing and general physical condition do not meet the minimum standards normally considered necessary, the Commission may approve the application and include conditions in the license to accommodate the physical defect. The Commission will consider the recommendations of the facility licensee or holder of an authorization and of the examining physician on Form NRC 396 in arriving at its decision." (2) Note: Since many NRC regulations seem to be permissive, there may be some question as to when standards are being applied rigidly and when a more permissive standard is in effect.

	AIR TRAFFIC CONTROLLERS (cont.)	PILOTS (cont.)	NUCLEAR POWER REACTORS OPERATORS (cont.)
POST-EMPLOYMENT PHYSICAL QUALIFICATIONS	"Each year, controllers must pass a physical examination." (3)	"All licenses are valid as long as a pilot can pass the required physical examinations and the periodic tests of flying skills demanded by government and company regulations." (3) "A first-class medical certificate expires at the end of the last day of "(1) The sixth month after the month of the date of examination shown on the certificate, for operations requiring an airline transport pilot certificate; "(2) The 12th month after the month of the date of examination shown on the certificate, for operations requiring only a commerical pilot certificate; and . . ." (4)	"During the effective period of a license the licensee shall, within fifteen days after its occurrence, notify the Commission of any disability referred to in 10 CFR Part 55.11 (a)(1) which occurs after the submittions of his medical examination form. Automobile or industrial accidents, injuries resulting from sporting events or any accidents, which reduces dexterity or mental alertness or should be considered as grounds to notify the Commission and temporarily remove the licensee from licensed duties." (2)
PRE-EMPLOYMENT EXAMINATIONS	Applicants "must pass a written test that measures their ability to learn and perform the controller's duties." (3)	"Because pilots must be able to make quick decisions and accurate judgments under pressure, airline companies give all applicants psychological tests and reject those who do not pass." (3)	

	AIR TRAFFIC CONTROLLERS (cont.)	PILOTS (cont.)	NUCLEAR POWER REACTORS OPERATORS (cont.)
LICENSING REQUIREMENTS	"They [air traffic contollers] must pass a job performance examination twice a year." (3)	Licensing procedures, qualifications, etc., vary with the level of the craft for which the individual is being licensed. It is noted: "All pilots who are paid to transport passengers or cargo must have at least a commerical pilot's license from the FAA. To qualify for this license, applicants must be at least 18 years old and have at least 250 hours of flight experience . . ." "Applicants must pass a written test that includes questions on the priciples of safe flight, navigation techniques, and FAA regulations. They also must demonstrate their flying ability to FAA examiners. "In addition to a commerical license, pilots who have to fly in bad weather must be licensed by the FAA to fly by instruments. Pilots may qualify for this license by having 40 hours of experience	"(a) No person may perform the function of an operator as defined in this part except as authorized by a license issued by the Commission; "(b) No person may perform the function of a senior operator as defined in this part except as authorized by a license issued by the Commission." (4) At large, a license is granted by the NRC for one unit only. Should a licensed operator move on to a second or subsubquent unit, a new license must be obtained. It is possible, however, to have a waiver of any further testing requirements, under certain circumstances, when extensions of licensing are granted by the Commission. "Pursuant to 10 CFR 55.31 (b) the license is limited to the facility for which it is issued. For sites which have more than one unit located thereon, each unit is considered a separate facility. Consequently, individuals licensed on one unit must submit applications for the subsequent units as appropriate."

	AIR TRAFFIC CONTROLLERS (cont.)	PILOTS (cont.)	NUCLEAR POWER REACTORS OPERATORS (cont.)
LICENSING REQUIREMENTS (cont.)		flying by instruments, passing a written examination on procedures and FAA regulations covering instrument flying, and demonstrating their ability to fly by instruments. "Airline pilots must fulfill additional requirements. They must pass FAA written and flight examinations to earn a flight engineer's license. Captains must have an airline transport pilot's license. Applicants for this license must be at least 23 years old and have a minimum of 1,500 hours of flying experience including night and instrument flying." The Department of Labor notes: "Companies other than airlines generally do not require as much flying experience. However, a commerical pilot's license is required and companies prefer applicants who have experience in the type of plane they will by flying. New employees generally start as co-pilots.	It is noted in CFR 55.11 (c) that: "The applicant's service as a licensed operator will be utilized on the facility for which he seeks a license or on a similar facility within the United States." Under 10 CFR 55.31, it is provided that: "(b) The license is limited to the facility for which it is issued." "(c) The license is limited to those controls of the facility specified in the license." The bases for the revocation of a license are set forth in 10 CFR 55.40. It is provided: "(a) The terms and conditions of all licenses shall be subject to amendment, revision, or modification by reason of amendments to the Act, or by reason of rules, regulations or orders issued in accordance with the Act or any amendments thereto. "(b) Any license may be revoked, suspended or modified in whole or in part for any material false statement in the application or any statement of fact

	AIR TRAFFIC CONTROLLERS (cont.)	PILOTS (cont.)	NUCLEAR POWER REACTORS OPERATORS (cont.)
LICENSING REQUIREMENTS (cont.)		Again, the Department of Labor notes: "Recent college graduates who have experience flying jet aircraft and who have a commerical pilot's license and a flight engineer's license can expect first consideration for jobs with the major airlines. Businesses generally have fewer formal education and experience requirements than airlines. However, these companies prefer applicants with experience in the type of plane they will be flying on the job." (3)	required under section 182 of the Act, or because of conditions revealed by such application or statement of fact or any report, record, inspection or other means which would warrant the Commission to refuse to grant a license on an original application or for violation of or failure to observe any of the terms and conditions of the Act, or the license, or of any rule, regulation or order of the Commission, or any conduct determined by the Commission to be hazard to safe operation of the facility." (2)
		"All licenses are valid as long as a pilot can pass the required physical examination and the periodic tests of flying skills demand by government and company regulations." (3)	"On application, the Commission may waive any or all of the requirements for a written examination and operating test if it finds that: "1. The applicant has had extensive actual

	AIR TRAFFIC CONTROLLERS (cont.)	PILOTS (cont.)	NUCLEAR POWER REACTORS OPERATORS (cont.)
LICENSING REQUIREMENTS (cont.)			operating experience at a comparable facility within two years prior to the date of application. A comparable reactor would normally be one where the class and operating characteristics of the reactor are similar to those of the reactor for which the application seeks a license (e.g., pressurized water power reactor, pool reasearch reaction, etc.). Applicable experience at a comparable reactor is not limited to licensed facilities. The granting of partial or complete waiver of examinations will depend upon both the extent and responsibilities of the applicants's prior experience, the characteristics and complexity of the facility, the similarity between the reactors being compared, and the applicant's past performance record as indicated by information contained in his docket file.

	AIR TRAFFIC CONTROLLERS (cont.)	PILOTS (cont.)	NUCLEAR POWER REACTORS OPERATORS (cont.)
LICENSING REQUIREMENTS (cont.)			"2. The applicant has discharged his responsibilities compentently and safety and is capable of continuing to do so. The Commission may accept as proof of the applicant's past performance a certificate of an authorized representative of the facility licensee by which the applicant was previously employed. The certification shall contain a description of the applicant's operating experience, including the number of startups and shutdowns and approximate total operating hours during which the applicant operated the controls of the facility, the duties performed, and the extent of his responsibility. "3. The applicant has learned the operating procedure for and is qualified to operate competently and safely the facility designated in his application. The Commission may accept as proof of the applicant's qualifications a certification of an authorized representative of the facility licensee . . . where the applicant's services will be utilized." (2)

	AIR TRAFFIC CONTROLLERS (cont.)	PILOTS (cont.)	NUCLEAR POWER REACTORS OPERATORS (cont.)
LICENSING REQUIREMENTS (cont.)			"Each operator and senior operator licensee (sic.) shall expire two years after the date of issuance." "If a licensee has not been actively performing the functions of an operator or senior operator for a period of four months or longer, he shall, prior to resuming activities licensed pursuant to this part, demonstrate to the Commission that the knowledge and understanding of facility operation and adminstration are satisfactory. The Commission may accept as evidence, a certification by an authorized representative of the facility licensee by which the licensee has been employed."(2)
POST-EMPLOYMENT TRAINING	"Successful applicants receive a combination of on-the-job and formal training to learn the fundmentals of the airway system, Federal aviation regulations, controller equipment, and aircraft performance characteristics. They	"New airline pilots usually start as flight engineers. Although airlines favor applicants who already have a flight engineer's license, they may train those who have only the commerical license. All new pilots receive several weeks of	"Workers operating nuclear controls must be licensed by the Nuclear Regulatory Commission. To qualify for a license, the trainees must pass an operating and a written test given by the NRC, along with a medical examination. The preparation for NRC licensing generally

	AIR TRAFFIC CONTROLLERS (cont.)	PILOTS (cont.)	NUCLEAR POWER REACTORS OPERATORS (cont.)
POST EMPLOYMENT TRAINING (cont.)	receive approximately 16 weeks of intensive training, including practice on simulators, at the FAA Academy in Oklahoma City. It then takes several years of progressively more responsible work experience, interspersed with considerable classroom instruction and independent study, to become a fully qualified controller." (3)	intensive training in simulators and classrooms before being assigned to a flight." (3)	lasts at least 1 year. Licenses must be renewed every 2 years, however, due to rapid technological change. Consequently, continual training is necessary. Additional preparation beyond the operator's license is needed for a senior operator's license, which authorizes the holder to supervise a nuclear control room. "All employees who work in the vicinity of radiation hazards are given on-the-job training in the nature of radiation and the procedures to follow in case of its accidental release." (3)

	AIR TRAFFIC CONTROLLERS (cont.)	PILOTS (cont.)	NUCLEAR POWER REACTORS OPERATORS (cont.)
PROMOTIONAL PATTERNS	"At airports new controllers begin in the tower, where they clear planes for takeoff. The next step is to ground controller followed by local controller, then departure controller, and finally, arrival controller. At a center, new controllers are first assigned to delivering teletyped flight plans to teams, gradually advancing to the position of manual handoff controller, then radar handoff controller. Failure to become proficient in any position at a facility within a specified time may result in dismissal. A substantial minority of controllers fail to complete either the academy or the on-the-job portion of the training program." (3)	"Advancement for all pilots generally is limited to other flying jobs. Many pilots start as flight instructors, building up their flying hours while they teach. As they become more experienced, these pilots occasionally may have the opportunity to fly charter planes and perhaps get jobs with small air transportation firms such as air traffic companies. Some advance to business flying jobs. A small number get flight engineer jobs with the airlines. "In the airlines, advancement usually depends on seniority provisions, of union contracts. After 5 to 10 years, flight engineers advance according to seniority to copilot and, after 10 to 20 years, to captain. Seniority also determines which pilots get the more desireable routes. In a nonairline job, a co-	

	AIR TRAFFIC CONTROLLERS (cont.)	PILOTS (cont.)	NUCLEAR POWER REACTORS OPERATORS (cont.)
PROMOTIONAL PATTERNS (cont.)		pilot may advance to pilot and, in large companies, to chief pilot in charge of aircraft scheduling, maintenance, and flight procedures." (3)	
EARNINGS AND FRINGE BENEFITS	"In 1978, controller trainees earned $12,500 a year; the average for all controllers was $25,400 a year . . . ." "Depending on length of service, they receive 13 to 26 days of paid vacation and 13 days of paid sick leave each year, life insurance, health benefits, and, due to the stress involved in the work, a more liberal retirement program than other Federal employees." (3)	"Earnings of airline pilots are among the highest in the Nation. In 1978, the average salary for airline pilots was $57,000 a year. Starting salaries for flight engineers averaged $14,400 a year, while some senior captains on the largest aircraft earned as much as $110,000. Earnings depend on factors such as the type, size, and speed of the plane, and the number of hours and miles flown. Extra pay is given for night and international flights. "Airline pilots generally are eligible for life and health insurance plans. They also receive retirement benefits and, if they fail their FAA physicals, disability payments. Some airlines provide allowances to pilots for purchasing and cleaning their uniforms. As an additional	

	AIR TRAFFIC CONTROLLERS (cont.)	PILOTS (cont.)	NUCLEAR POWER REACTORS OPERATORS (cont.)
EARNINGS AND FRINGE BENEFITS (cont.)		benefit, pilots and their immediate families usually are entitled to a limited amount of reduced fare transportation on their own and other airlines. "According to a survey by a business aircraft association, earnings of business pilots ranged from $12,000 for copilots on small planes to $60,000 for some chief pilots of companies with large jets. Average salaries of business pilots were $19,000 for those flying light piston planes, $24,500 for light turboprop planes, and $34,000 for jet aircrafts. Business pilots usually are eligible for the same benefits as other employees of their company. "According to a survey by an air transportation association, flight instructors working for air taxi companies averaged $8 an hour. Benefits in air taxi companies vary widely. Some of the large firms offer health and life insurance as well as pension plans to their employees. Some smaller companies offer none of these." (3)	

Appendix B

Nuclear Regulatory Commission Organization

Reprinted From
Report to the Senate, Nuclear Accident and Recovery at Three Mile Island:
A Special Investigation

Appendix B

Nuclear Regulatory Commission Organization

The Energy Reorganization Act of 1974, (1) effective January 19, 1975, (2) created the Nuclear Regulatory Commission (NRC) and (3) transferred to it the licensing and related regulatory functions of the Atomic Energy Commission, which was abolished.

The Act specified three new program offices for the NRC. They were Nuclear Material Safety and Safeguards, Nuclear Reactor Regulation and Nuclear Regulatory Research. Two other offices—Standards Development and Inspection and Enforcement—were subsequently set forth in the Code of Federal Regulations. (4)

NUCLEAR REACTOR REGULATION

The Reorganization Act charged the Office of Nuclear Reactor Regulation (NRR) with licensing functions associated with the construction and operation of those reactor facilities that must be licensed, according to the Atomic Energy Act of 1954, as amended. This Office licenses the receipt, possession, ownership and use of special nuclear and byproduct materials used at reactor facilities.[1] In addition, NRR evaluates the health, safety and environmental aspects of nuclear facilities and sites; develops and administers regulations; licenses reactor operators; analyzes reactor design concepts; evaluates methods of transporting nuclear materials and radioactive wastes on reactor sites; monitors and tests operating reactors; and recommends upgrading of facilities or modification of regulations. NRR also provides assistance in matters involving reactors or critical facilities exempt from licensing.

DIVISIONS WITHIN NRR

At the time of the accident there were four major Divisions within the Office of Nuclear Reactor Regulation: Operating Reactor (DOR), Project Management (DPM), Site Safety and Environmental Analysis (DSE), and Systems Safety (DSS).

The Division of Operating Reactors (DOR) reviewed changes in the design and operation of operating reactors. It analyzed operating experience (e.g. incidents), some of which, such as increased testing or surveillance, have to be accounted for in new licensing actions.

The Division of Project Management (DPM) administered the reviews of reactor safety through the Operating License stage, and was responsible for coordinating and scheduling the review by the technical review staff. This Division was also responsible for the examination and licensing of reactor operators and senior reactor operators.

The Division of Site Safety and Environmental Analysis evaluated all reactor sites for potential health, safety and environmental impacts.

The Division of Systems Safety (DSS) evaluated the safety issues associated with the design of the facility in both Construction Permit and Operating License applications.

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[1] Special nuclear material refers to plutonium, uranium 233, uranium enriched by the isotopes 233 or 235, and any other material which the Commission, pursuant to the provisions of section 51 of the Act, determines to be special nuclear material, as well as any material artificially enriched by any of the foregoing.

Special nuclear materials do not include source materials. These are uranium or thorium, or any combination of them. in any physical or chemical form, and ores which contain by weight 0.05% or more of uranium, thorium or any combination of them.

Byproduct material means any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation during the process of producing or utilizing special nuclear material.

NUCLEAR MATERIAL SAFETY AND SAFEGUARDS

The Office of Nuclear Material Safety and Safeguards (NMSS) is chartered under the Reorganization Act with responsibility for licensing and regulating all facilities and materials licensed under the Atomic Energy Act of 1954, as amended, associated with the processing, transport and handling of nuclear materials. Among its duties are to review and assess the licensee's safeguards against potential threats, thefts and sabotage of those materials.

NUCLEAR REGULATORY RESEARCH

Finally, the Energy Reorganization Act charged the Office of Nuclear Regulatory Research (RES) with planning, recommending and implementing those nuclear research programs related to the NRC's licensing and regulatory functions. There are two formal research divisions within RES: the Division of Reactor Safety Research (RSR) and the Division of Safeguards, Fuel Cycle and Environmental Research.

The Division of Reactor Safety Research plans and oversees programs relating to the safety of civilian power and advanced reactors and to the behavior of reactor components and systems under accident conditions.

The other Division of RES—Safeguards, Fuel Cycle and Environmental Research—plans and oversees programs relating to safeguards, fuel cycle and environmental research.

STANDARDS DEVELOPMENT

The Office of Standards Development, as defined in the Code of Federal Regulations, focuses on NRC rules, regulations, standards and guides governing the licensing of nuclear facilities and the commercial use of nuclear materials.

Its Division of Engineering Standards (DES) directs the development of standards and regulations for safe design, construction, other production and utilization facilities and facilities for the storage, processing and use of nuclear materials. Similarly, it develops regulations and standards for the production, use and transportation of radioactive materials. This Division also is responsible for providing technical assistance on generic issues related to nuclear wastes and fuel cycle facilities. It works with the American National Standards Institute (ANSI) as well as other Federal and international agencies.

Also within the Office of Standards Development is the Division of Siting, Health and Safeguards (DSHS). Its focus is on radiological protection, environmental impacts and safeguards for nuclear facilities.

INSPECTION AND ENFORCEMENT

The Office of Inspection and Enforcement (I&E) consists of a headquarters group and five regional offices. I&E's purpose is to ascertain compliance with the NRC's licensing regulations, orders and conditions through the development of policies and programs for the inspection of licensees, applicants and their contractors and suppliers. I&E further ensures safety by identifying conditions that may adversely affect public health and safety, the environment or the safeguarding of nuclear materials and facilities. This Office also makes recommendations on the issuance of authorizations, permits or licenses and determines the adequacy of the licensee's quality assurance programs. Finally, I&E develops enforcement policies and recommends or takes appropriate action regarding incidents or accidents.

HUMAN FACTORS

In additional to these five major offices, there are interoffice Research Review Groups whose purpose is to monitor and direct research programs in specific areas. One such group is the Human Engineering Research Review Group, which was formed in 1976. (5) Its members include designated representatives from the Office of Inspection and Enforcement, the Division of Operating Reactors, NRR, the Office of Standards Development, the Office of Management and Program Analysis and the Probabilistic Analysis Staff, RES. The Review Group uses the services of industry consultants. It focuses on human factors engineering and other safety-related aspects of plant operations, and outlines and recommends additional research projects to be undertaken by the NRC.